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PIPE LINE INDUSTRY

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API TRANSPORTATION ISSUE

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WARTIME SECURITY

A plea for realistic thought and action to insure continuous operation of America's commercial oil and gas pipe line systems in the event of an all-out war. Page 18

UNATTENDED PUMP STATIONS

Operating experience with five remote-controlled, unattended, electrically-powered pumping stations provides ideas for future installations. Page 21

AERIAL MAPPING

A new and novel system of aerial mapping warrants the closest scrutiny of the industry, conference is told. Page 26

EFFECT OF DISTILLATE VOLUMES ON CAPACITY

An approach to the problem of evaluating the effect of distillate volumes on pipe line capacity, which is necessary in dividing pipe line time equitably among participating shippers. Page 30

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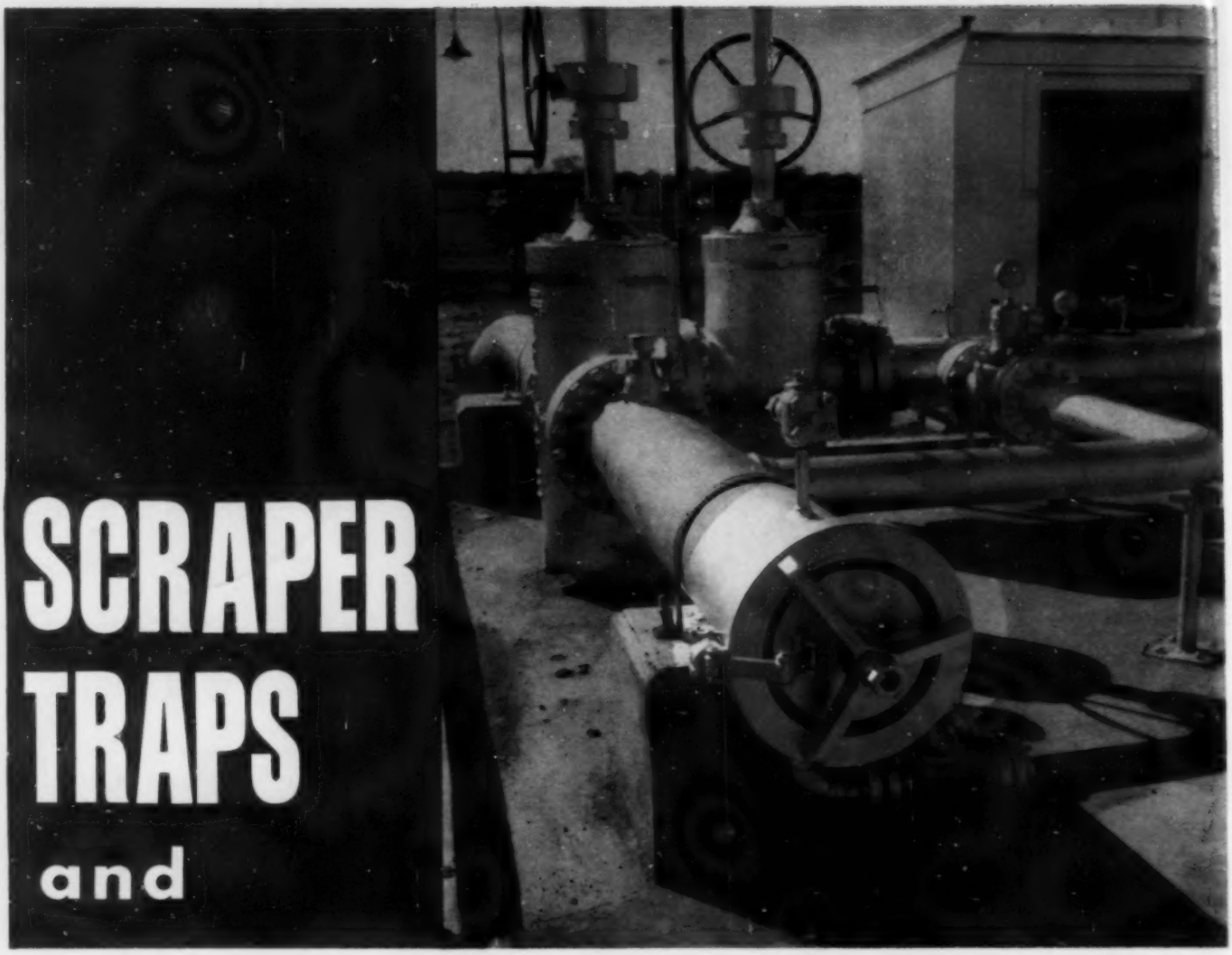
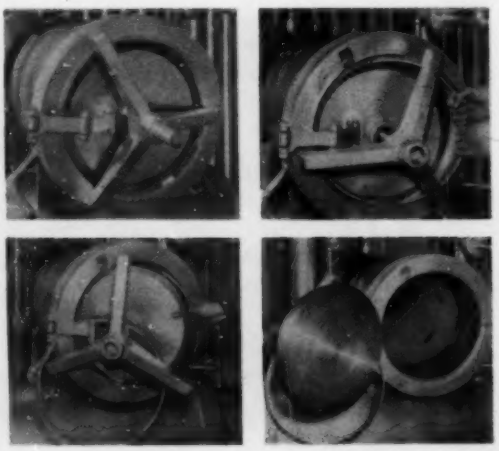


SCRAPER TRAPS and

SILLERS FLEX RING CLOSURE



(1). Flex Ring Unit assembled as in service. (2). Spider released gasket being removed. (3). After gasket is removed, plug is rotated to open. (4). Unit completely opened and in a fraction of the time taken for conventional type closures.

Pictured above is an installation of a 14" ASA Sillers Flex Ring Closure on a Scraper Trap. This installation is located at a pumping station of a major products pipeline company in Eastern Oklahoma. Some of the outstanding advantages of the Sillers Flex Ring Closures over conventional, cumbersome flanged closures are: LESS TIME FOR OPENING (one bolt), LOWER INITIAL COST, TIGHTER SEAL, LESS WEIGHT, and SPACE SAVING. The metal seal ring makes the Sillers Closure highly favorable because it is NOT SUBJECT TO DESTRUCTION IN CASE OF FIRE. Sillers also specializes in the design of Scraper Traps and can furnish completely fabricated traps with closure installed and adjusted.

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JUN 14 1955

PIPE LINE INDUSTRY

CONTENTS and Quick Review

June, 1955 Vol. 2, No. 6

To help you put first things first, scan these time-saving digests, checking ☑ those you want to read first.

API Transportation Conference features indicated by titles in blue

Wartime Security Measures for Pipe Lines

☐ Here's a plea for realistic thought and action to insure continuous operation of America's commercial oil and gas pipe line systems in the event of an all-out war. Security measures were suggested for pipe lines, tank farms, and pump stations. Precautions include a warning against over-centralization of administration and communication centers, strategic placing of skilled maintenance crews, and stockpiling of repair materials and equipment.

By C. B. Lester and H. T. Chilton, Jr. ..... Page 18

Remotely-Controlled and Unattended Pump Stations

☐ A roundup of design features and maintenance procedures that operating experience with unattended pumping stations has indicated to be desirable. The authors point out that an unattended station must "think for itself" and try to protect not only itself but its neighbors from the hazards it may introduce. Separation of the pumping building and control-gear building is desirable. Other facets discussed include equipment research, leased wire circuits, microwave radio equipment, and coordination between mechanical and electrical maintenance groups.

By T. V. Bockman and R. S. Cannon ..... Page 21

Routing Pipe Lines by Aerial Surveys

☐ A new and novel system of aerial mapping is recommended to the industry for the closest scrutiny. The requirements of war brought forth techniques and camera equipment that literally telescoped mapping into the jet age, the author points out. Among the advantages claimed: cost reduction of as much as $40 per mile and greater detail and wider coverage of the area to be mapped.

By Paul J. Gibbs ..... Page 26

How Do Proportional Middle-Distillate Movements Affect Pipe Line Capacity?

☐ Dividing pipe line capacity between participating shippers on an agreed basis is an operational requirement at Trans-Northern Pipe Line Company. If you have a similar problem, this analysis of two years of satisfactory operation will be of help. Several factors which apparently contribute to the effect on over-all pipe line capacity as the result of distillate movements through the pipe line system are appraised.

By J. R. Childs ..... Page 30

When Does Cathodic Protection Pay Out?

☐ How much does it cost to protect bare lines. How economical is pipe line coating? Does coating always pay out? An economic survey of underground corrosion preventive measures has produced some surprising results. The survey was based on data collected from 28 pipe line companies.

By Dean C. Glass ..... Page 37

Transco's Alabama-Georgia Line

☐ Welders use stepladders to reach the top of the pipe. A 42-inch wide bulldozer nicknamed the "kittypillar" crumbs out the bottom of the mammoth ditch. These are but two examples of the gigantic size of the operation along Transcontinental's right-of-way in Alabama and Georgia.

By Donald M. Taylor ..... Page 39

Ultra-Modern Unit Replaces 39-Year-Old Oil Pump Station

☐ A thoroughly modernized station has replaced a 39-year-old steam-powered oil pumping installation. New station features remote control of gas engine-driven centrifugal pumps, soundproofing construction, and many automatic safeguards. Included in this issue is an illustrated description of the new station.

By F. E. Sesler ..... Page 44

Engine-Driven Centrifugal Compressor Fitted For Automatic Operation

☐ Something new has been added—the combining of gas engines and centrifugal compressors under a supervisory control system for automatic operation. Here is an engineer's suggested design. A similar one has been in service on a reciprocating compressor at Northern Natural Gas Company for seven months.

By David M. Salls ..... Page 50

Multi-Lines Laid Together as a Bundle

☐ Four pipe lines, plus a multiple conductor submarine telephone cable, all banded together with heavy metal straps to make a single circular-shaped bundle, were pulled and laid across 8300 feet of water. Some unusual problems were encountered and the techniques used may point the way to future multiple-line submarine operations.

By Gilbert M. Wilson ..... Page 55

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PIPE LINE INDUSTRY published every month Entered as second class mail matter July 9, 1954, at the post office at Houston, Texas, under the act of March 3, 1879.

Better Understanding Is Needed

Hopes for the future in America depend upon maintenance of a free enterprise system under which both labor and capital can operate. Continued prosperity is a necessity for both. More effort needs to be made to create greater trust and understanding between the two.

George V. Holton, chairman of the board of Socony Mobil Oil Company, made the following pertinent observations on this subject at the company's annual shareholders meeting:

"A serious business recession is being predicted by various groups. My hunch is that if we are in for bad times they will result in no small part from our impatience to own everything we want today instead of waiting until tomorrow, when we can better afford it. The over-generosity of government with the taxpayers' dollars for give-away purposes which have such an alluring social appeal, could hasten the day of reckoning that always comes when for too long we continue to spend more than we receive.

"One who expresses this view risks being regarded as opposed to social betterment, which I am not. The all too common failure to distinguish between desirable objectives and what must be done to achieve them is but another manifestation of our national impatience. From it arise the recurring arguments between those who want to march now to the Promised Land across the river, and those who, in case no one is around to roll back the river, favor building a bridge first. The bridge to lasting social gains is the creation of enough earning power to support them. The more we spend future income to satisfy today's wants, the more we are inclined to demand guarantees that such future income be uninterrupted no matter what happens—and the less able we are to meet such guarantees.

"Continued prosperity will depend in no small degree upon the relationship between capital and labor. Here again there is cause for concern. If we are to continue to benefit from free enterprise, business must be permitted to operate at a profit. It cannot do so if costs are greater than income. A major cost item in most businesses is labor. Consequently, the attitude of labor has an important bearing on whether or not there is to be any profit. In mentioning this I am not hinting at any sacrifices by labor for the benefit of shareholders. Rather I am trying to make clear that only through a friendly and cooperative relationship between those who invest their savings and the employees can there be a profitable business of lasting benefit to either . . .

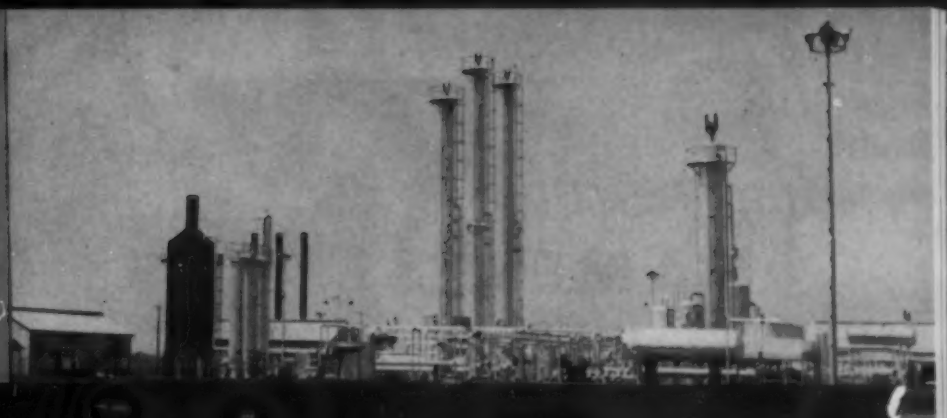
"I see serious trouble ahead for the country as a whole if monopolistic unionism as found in a number of companies and industries becomes more widespread . . . When as a result of unreasonable demands labor costs reach a point which preclude a fair profit to the owners, they must be passed on to the consumer or the business will die. The business will also die if the price to the consumer becomes so high he cannot or will not buy.

"Elementary as is what I have said, these facts do not seem to be recognized by some very vocal and influential labor spokesmen. Their normal approach, perhaps copied after that unwisely adopted by management in another generation, is with a raised club and threats to close shop regardless of who may be hurt unless their specific demands, however, debatable, are met in full. If this type of approach, accompanied by the countenance of force, is to prevail, we shall have, in addition to economic chaos, both our business and our government run by a labor monopoly which is just another form of dictatorship. I doubt if this would benefit any of us very much, the union member not excepted . . .

"The seriousness of the situation would be greatly relieved if all concerned would direct more effort toward creating the trust and better understanding upon which the will to adjust differences through amicable compromise must rest. As opposed to this, unfortunately, people in high places with loud voices and ulterior motives have been for years purposely stirring up antagonisms between the components of our economic system. Management must do what it can to foster the loyalty and friendly support of each of its employees, whatever his or her job. Upon the success of such efforts and the cooperation of labor will depend in large measure the future of free enterprise."

Warren L. Baker

...n the R. R. Dean
...rocessing Plant
...ear Agua Dulce, Texas



Quintuplex Plunger Pumps

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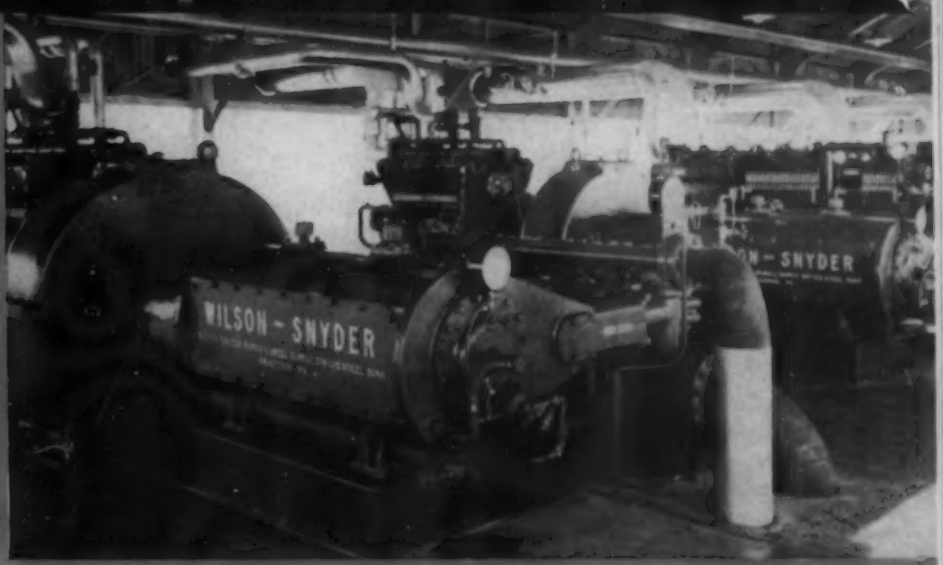
in the absorption
process at

HIGH PRESSURE



ENGINEERING, design, and construction of this plant were performed by O. L. Olsen Company of Houston, Texas for the Tennessee Production Company.

It was designed to process 100,000,000 cubic feet of gas per day, "floating" on Tennessee Gas Transmission Company's line pressure of 800 pounds; total plant pressure drop 8 pounds.

In the absorption process, two No. 558-P Wilson-Snyder Quintuplex Plunger Pumps recycle lean oil after it is refrigerated to 50 degrees F. Equipped with hardened steel plungers, heat-treated stainless-steel wing-guided valves and seats and driven through speed reducers by 340-hp Le Roi gas engines, each pump is capable of delivering 510 gpm at 1270 psi.

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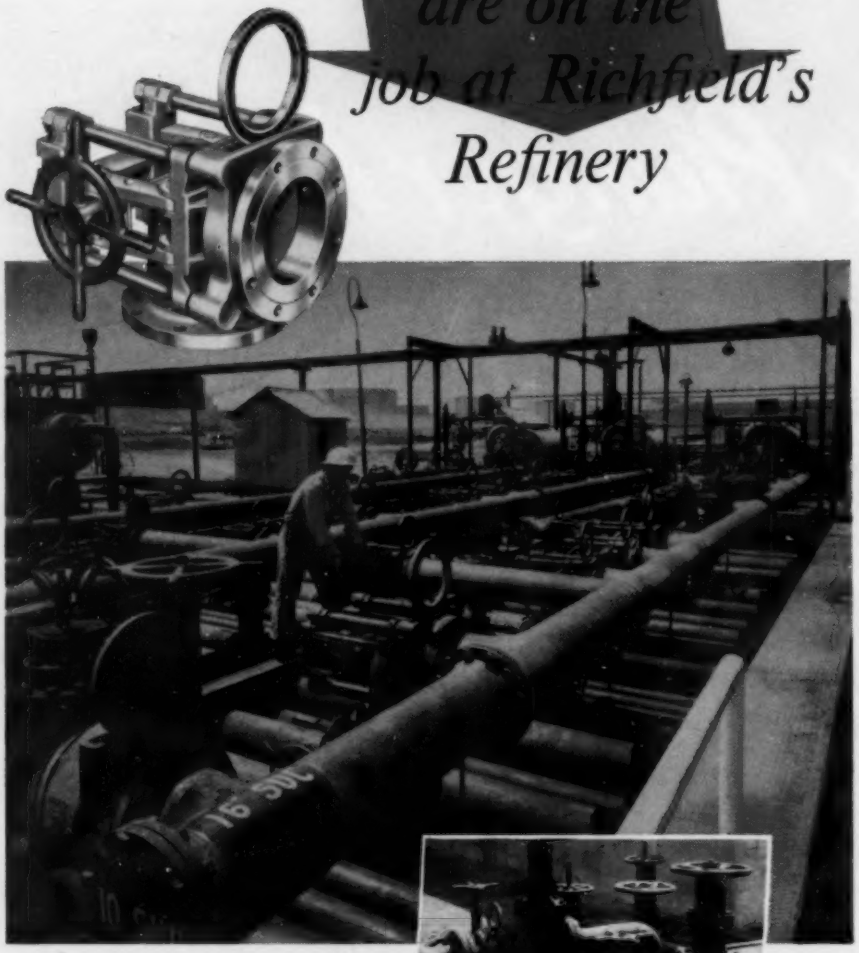

After testing their action in a trial installation, Richfield now uses Hamer Line Blinds extensively at its refinery at Watson as illustrated above.

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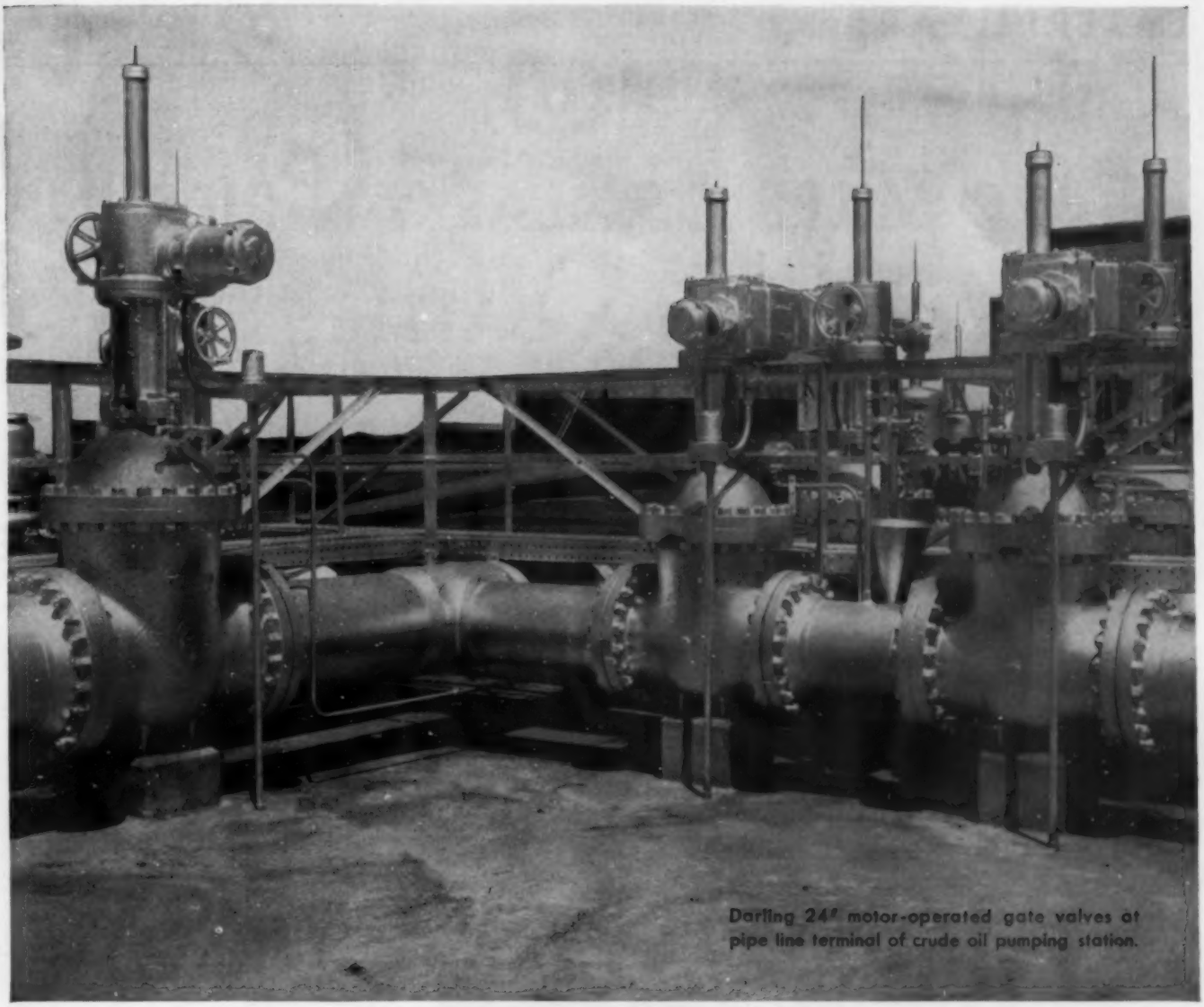


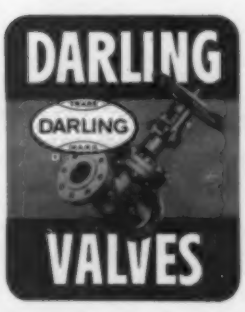
Darling 24" motor-operated gate valves at pipe line terminal of crude oil pumping station.

Why Darling gate valves work better...longer!

HERE'S the simple answer. There's little that *can* go wrong with Darling *fully revolving double disc, parallel seat gate valves.* This unique principle recognizes and thus *avoids* the common sources of valve failure...

Take seat misalignment for example. The Darling principle automatically compensates for this common cause of leaks! Then too, there's *uniform* distribution of disc-and-seat wear, positive relief of wedging pressure as discs unseat, and *easier operation* even under pressure and temperature extremes.

Finally, with these Darling gate valves that work better, longer, you naturally minimize down time and maintenance expense. Why not get all the facts on Darling gate valves of the proper size and type for your own service needs? We'll be happy to cooperate.



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UNDER THE MUSKEG, PERMAFROST. A Cleveland ditcher powered by a D8800 digs through a layer of muskeg and then through hard permafrost. A D6 is towing the ditcher while a Bucyrus-Erie backhoe, powered by a D315 Engine, backfills.

TWO LINCOLN WELDERS are mounted on a D6. In good weather the welding crews, seen here near Dot Lake, Alaska, have been averaging four miles a day.

Nature has been throwing the book at Williams Brothers Co. since December, 1953. On that date, the Tulsa pipeliners began working on the Haines to Fairbanks Pipeline, one of the most ambitious welded pipelines ever attempted.

It's been a grueling, ask-no-quarter test for crews and machines. But they're bringing the job in on schedule—these doughty pipeliners from all over the U. S. and their all-CATERPILLAR* fleet of pipelayers, 'dozers, engines and electric sets.

Clearing began in December, 1953, with snow drifted up to six feet and 15 days of temperatures ranging from 30 to 60 below. But D8s equipped with No. 8A Bulldozers cleared a mile a day, increasing to 2½ miles a day as weather improved. Covered at night with tarps and warmed by eight No. 2 kerosene lanterns, the CAT* D8 Tractors started easily each day.

In April, the first of five big yellow tractors plunged through the ice—only

IN A MUSKEG SWAMP A D6 equipped with a No. 6A Bulldozer backfills a trench. A D8 is being used as a stomper to hold down the pipe.

a few feet of its 22-foot boom showing. Recovered and flushed out, the D6 went back on the job with only a bent boom to show for its experience.

Half the Alaskan section of the line is underground. To tuck it in, Williams Brothers proved it was possible to dig permafrost with a ditcher. A D8800 powered the Cleveland ditcher and a lead Cat D6 dragged the ditcher more than 110 miles.

In the water-covered muskeg swamps there was a double problem. Under the moss-like muskeg lay permafrost. Skillful operators kept the big yellow tractors moving—although they might have been mired by the muskeg or slipped helplessly on the hard permafrost. But the Caterpillar D6 Tractors, with their oil clutches, kept production as high as 3500 feet of ditch in 24 hours. And only two clutch adjustments were required during the entire operation.

"Those oil clutches are giving awfully good service," reports E. M. Hubach, Superintendent of the Canadian section of the job. "Only one had a disc break and they've rarely been adjusted. Our Cat machines stay with us. They walk right through that muskeg."

The Canadian section of the job has a complete spread of Caterpillar-built equipment—eight pipelayers, four bulldozers, three tow tractors and two Cat powerplants on Bucyrus-Erie Shovels.

And each of the three comfortable crew camps for more than 300 men has been powered by Caterpillar D8800 Electric Sets.

The performance of all this equipment has proven once again that tough jobs are Caterpillar jobs.

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LINE PIPE

With the installation of facilities for hydraulic expansion well under way at the Steelton, Pa., plant, Bethlehem Steel Company will soon be able to furnish an unusually wide range of welded, large-diameter line pipe to the oil and gas industries. We invite your inquiries.

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For further information about Bethlehem Oil & Gas Pipe, please contact the Bethlehem sales office nearest you.

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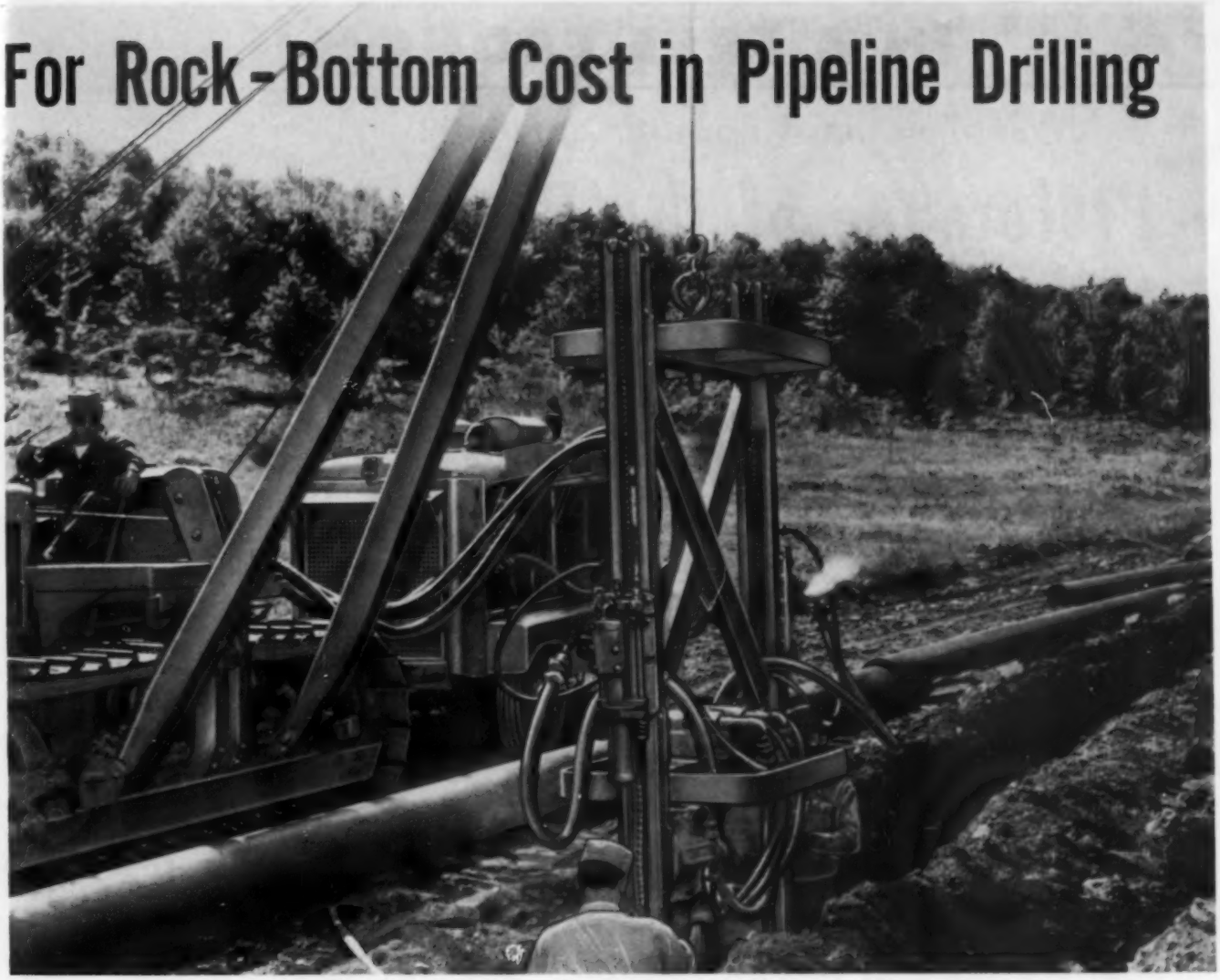

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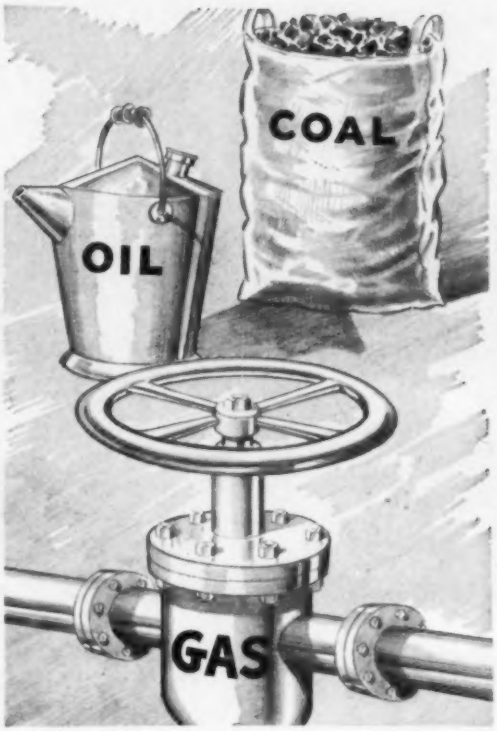

AT THE ends of the gas lines that come out of the Southwest the customer has his choice of fuels—coal, oil or natural gas.

Gas has come along rapidly. In 1932 it provided fuel for less than 10 per cent of the nation's total energy needs; now it fulfills 25 per cent of those needs. Since it is the most convenient of the three, a proper conclusion would be that it would command the highest price.

Contrariwise, it happens to be the cheapest of the three fuels for home heating, on a price adjusted to efficiency basis. A recent study of eight cities, Chicago, Cleveland, Detroit, Minneapolis, New York, Pittsburgh, St. Louis and Washington revealed that gas costs less than the other two fuels in each of these except Washington. It is more expensive than coal in New York, where the comparison was with an especially screened anthracite product rather than bituminous coal. Only the nation's Capitol offers the home owner gas at a price higher than either coal or oil.

In time this may change. What is certain is that the home owner never will pay more for gas than he pays for coal or oil, unless he chooses to do so, since all three are available and he is free to select as his preference dictates.

What is more, should the price of gas get out of line, the home owner has the means of pulling it back by shifting to some other fuel. And this is a quicker and more effective regulation of price than can ever come out of the price-fixing deliberations of any bureau in Washington.

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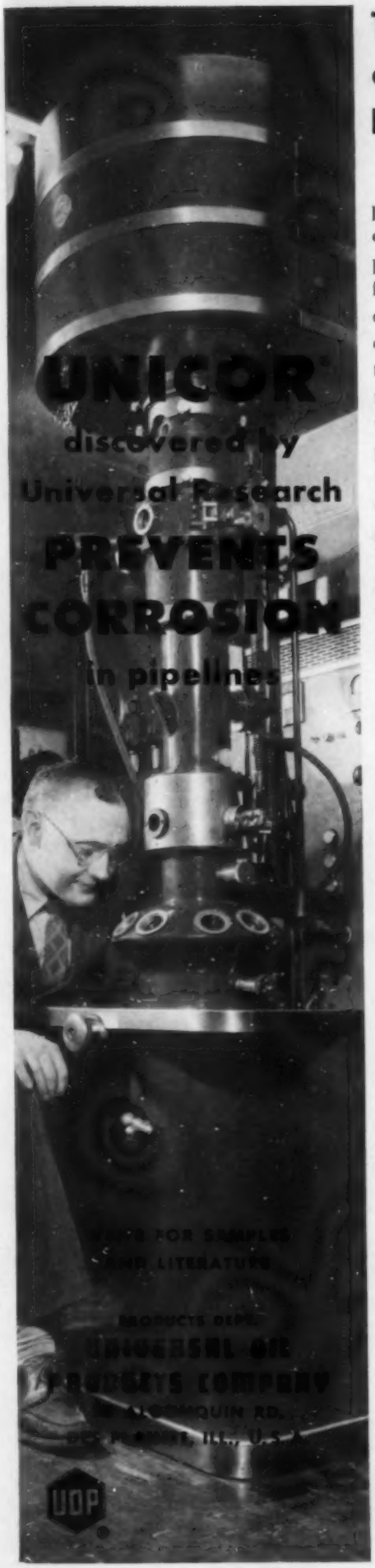


The Control of Corrosion, Fouling and Product Contamination in Pipelines, Storage Tanks & Tankers

The corrosion problems of the petroleum industry may be roughly classified into three parts, namely, (a) production or oil well problems, (b) refinery problems dealing with process equipment and (c) corrosion problems of the transportation division, such as those occurring in pipelines, storage tanks and tankers. In this discussion we are considering only the corrosion problems associated with the transportation and storage of highly refined distillate products. For example, with gasoline or jet fuel the corrosion problem is usually one of rusting caused by moisture. The resultant peptized rust stabilizes an emulsion of minute particles of water fog causing a contaminated gasoline or an unsafe jet fuel.

Methods of proved merit for preventing this situation include (1) product dehydration, (2) the use of nitrite, chromate or other water-soluble rust preventives, (3) the addition of oil-soluble, film-forming, organic inhibitors, (4) the use of special alloy or plastic pipe and (5) interior plastic coatings or liners.

A substantial and significant amount of evidence from laboratory and field sources during the past year has confirmed the need for using oil-soluble corrosion inhibitors for the maximum protection of pipelines and tankers. The unique position of Unicor in this class of inhibitors is apparent to pipeline operators for the following important reasons:

Unicor prevents rusting in product pipelines at concentrations well below 10 ppm. Since it is distributed uniformly over the entire internal surface by the product itself, this protection is virtually 100% effective.

Unicor is slime-detergent and anti-fouling. No rusting can occur since Unicor's surface-activity causes a water-repellent film to be formed on the pipe's interior. This film sheds corrosive droplets.

Unicor is economical by virtue of (a) its low cost which is about 0.05c/bbl. of pipeline product, (b) the minute concentrations required and (c) its persistence in products from the refinery through the pipeline to the consumer, making re-inhibition unnecessary.

Water in a products pipeline is destructive. Its addition is unnecessary with Unicor. Unicor will also prevent rusting caused by unavoidably entrained or dissolved moisture.

Mechanical cleaning maintenance is materially reduced. The use of scrapers and the replacement of filters is reduced by over 50 per cent.

The beneficial effect of Unicor will extend to pipelines, storage tanks, tankers and ultimately even to consumer equipment when it is added within the refinery.

Addition at only one point is required since Unicor is distributed by the oil phase and is unaffected by water.

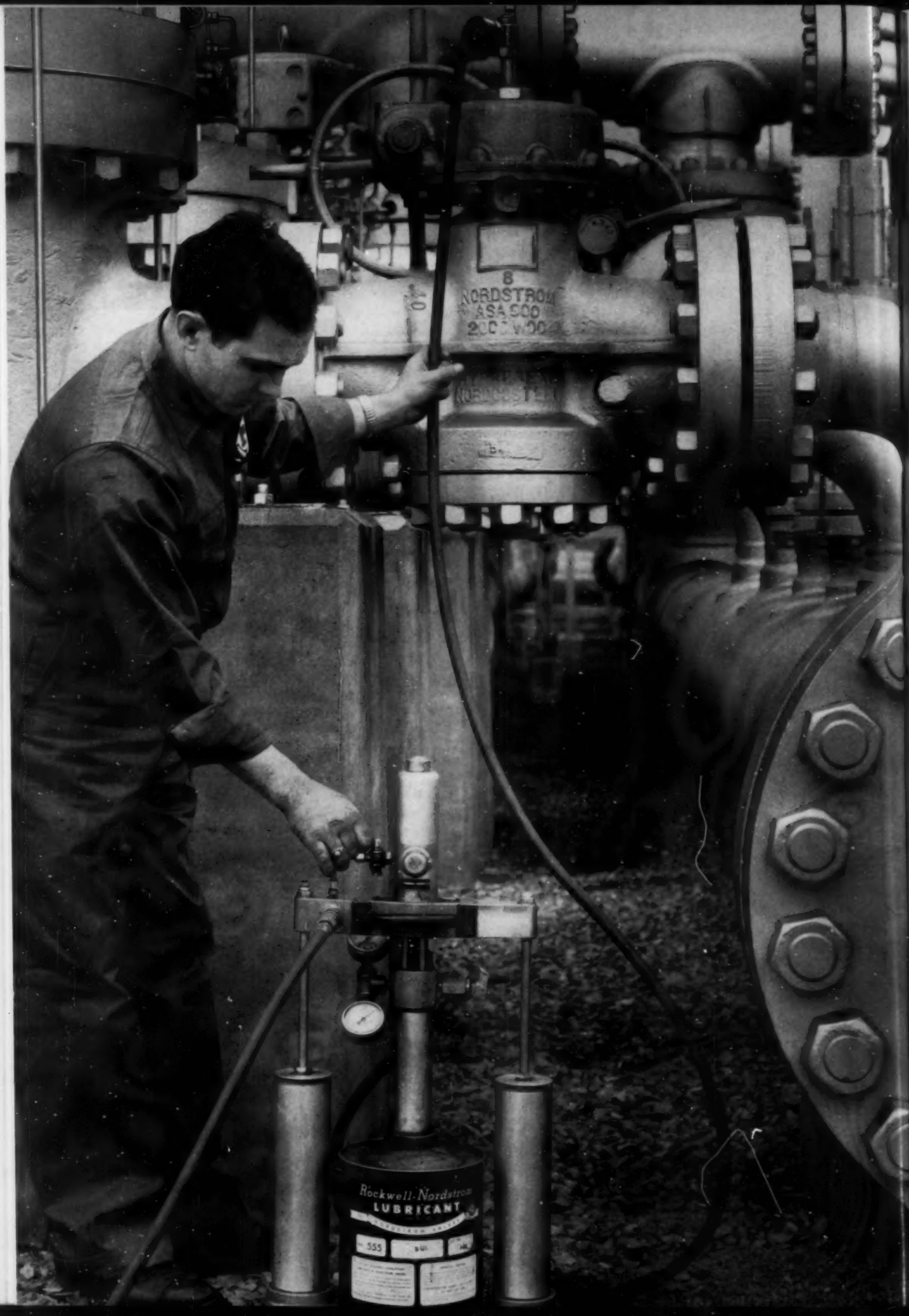
Unicor will not interfere with the action of other useful additives such as tetraethyl lead, antioxidants and dyes, and it has been especially prepared to avoid deleterious effects on gasoline stability.

Unicor has been formulated to meet the exacting water tolerance requirements of ASTM D910-53T as determined by ASTM D1094-53 in regard to entrainment of moisture and rust in hydrocarbon fuels. Unicor treated fuel rejects moisture.

Unicor is a non-irritating, non-toxic inhibitor; safe to handle and easy to apply.

Unicor is sold exclusively by Universal Oil Products Company. The technical services of petroleum specialists are available without charge to assist in the design, installation, and operation of a Unicor system of protection. For samples and information, write to Products Department, Universal Oil Products Company, 30 Algonquin Road, Des Plaines, Illinois.

(Adv.)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—the major source of valve wear. As in your automobile engine, lubrication assures longer life and better performance. Pressurized lubricant also forms a remarkably leakproof seal between the plug and the valve body. This lubricant seal has proven far more effective than the uncertain metal-to-metal seal in ordinary valves where a tiny scratch means leakage . . . and eventually, expensive reseating.

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A few cents worth of lubricant buys three things: 1. *new seats* (renewing the lubricant is like reseating an ordinary valve) . . . 2. *smooth, dependable operation* and . . . 3. *savings* in terms of lower repair, replacement and down time expenses. It is not the cost of the lubricant that is important, but the *savings* through longer, more dependable life of the working parts and better performance.

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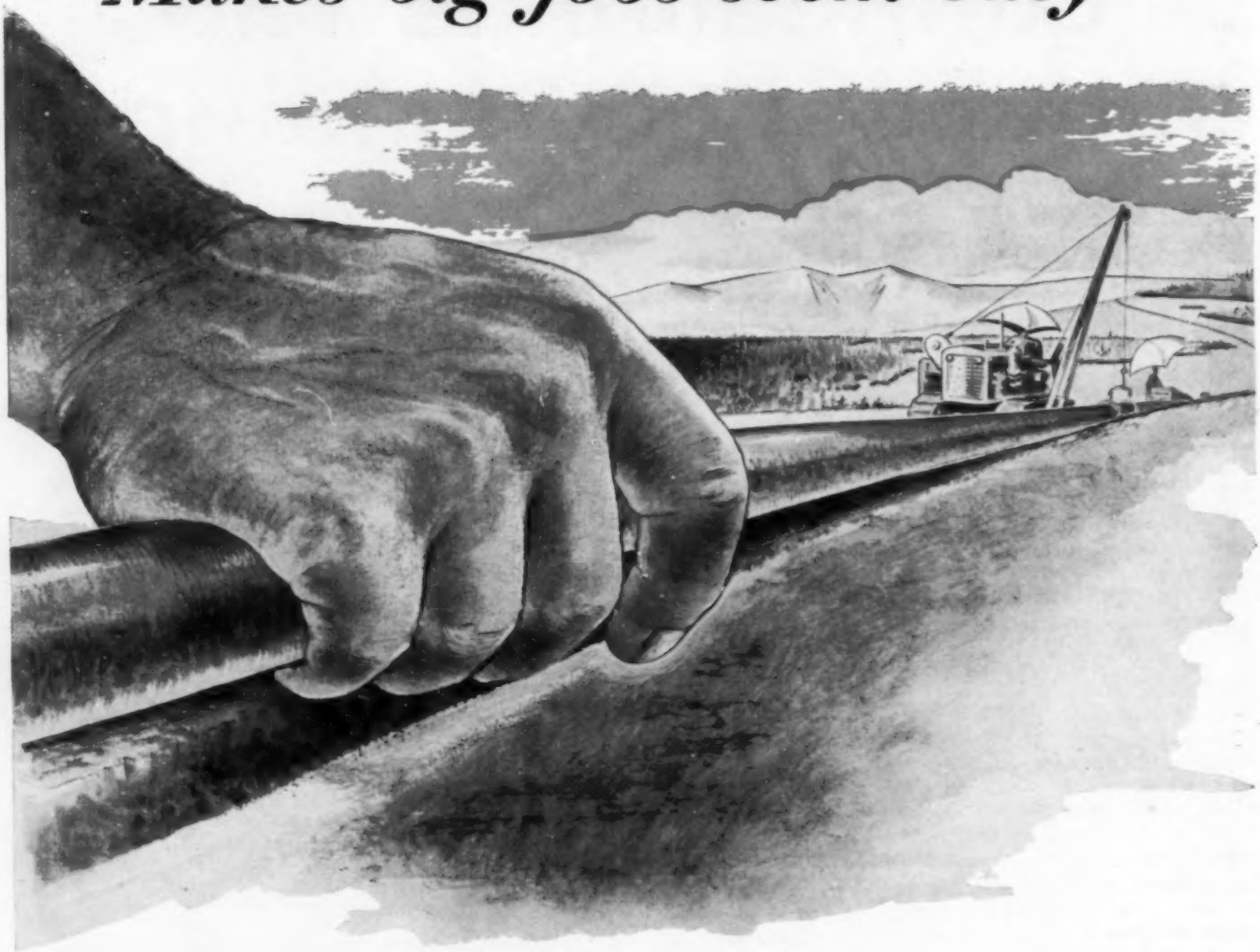

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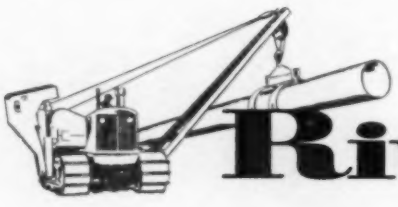

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WHO'S MEETING WHERE

JUNE	
1– 3	Annual Short Course in Gas Technology, Texas College of Arts and Industries, Kingsville, Texas.
5– 9	Canadian Gas Association, Annual Meeting, Sheraton Brock, Niagara Falls, Ont.
6– 9	American Society of Mechanical Engineers, Oil and Gas Power Division, Hotel Statler, Wash.
6–15	Fourth World Petroleum Congress, Rome, Italy.
7– 9	Mid-West Gas Association, Gas School and Conference, Iowa State College, Ames.
7–10	American Welding Society, Hotel Muehlebach, Kansas City.
9–10	Natural Gas and Petroleum Association of Canada, Royal Connaught Hotel, Hamilton, Ont.
11–15	Petroleum Equipment Suppliers Assn., Banff Springs Hotel, Banff, Alberta.
13–17	American Society of Civil Engineers, Committee on Pipelines, St. Louis.
20–23	American Society of Mechanical Engineers, Semi-Annual Meeting, Hotel Statler, Boston.
23–26	Rocky Mountain Oil Show, Casper, Wyo.
26–July 1	American Society for Testing Materials, Chalfonte-Hadden Hall, Atlantic City.
27–28	Michigan Gas Association, Mackinac Island, Mich.
AUG.	
29–31	Appalachian Gas Measurement Short Course, West Virginia University, Morgantown.
SEPT.	
11–13	Independent Natural Gas Association of America, Jasper Park Lodge, Jasper, Alberta.
12–14	American Institute of Electrical Engineers, Houston Section, Electrical Conference of the Petroleum Industry, Shamrock Hotel, Houston.
12–16	Instrument Society of America, Conference and Exhibit, Los Angeles.
12–16	Corrosion Short Course, Washington University and St. Louis Section, National Association of Corrosion Engineers, St. Louis.
13–24	International Instrument Congress and Exposition, Philadelphia.
14–16	National Petroleum Association, Annual Meeting, Traymore Hotel, Atlantic City, N.J.
22–23	Mid-Continent Oil & Gas Association, Louisiana-Arkansas Division, Membership Meeting, Roosevelt Hotel, New Orleans.
25–28	American Society of Mechanical Engineers, Petroleum Mechanical Engineering Conference, Roosevelt Hotel, New Orleans.
27–30	International Gas Union Conference, Hotel New Yorker, New York.
OCT.	
2– 6	American Society for Testing Materials D-2, Petroleum Products and Lubricants, Statler Hotel, Washington.
3– 7	American Institute of Electrical Engineers, Morrison Hotel, Chicago.
17–19	American Gas Association and Pacific Coast Gas Association, Statler Hotel, Los Angeles.
17–21	National Safety Congress, National Safety Council, Chicago.
27–29	Rocky Mountain Oil & Gas Association, Cosmopolitan Hotel, Denver.
NOV.	
14–17	International Automation Exposition, Navy Pier, Chicago.
14–17	American Petroleum Institute, Annual Meeting, Mark Hopkins, Fairmont, St. Francis and Palace Hotels, San Francisco.

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AN API FEATURE

Here are some precautions that should be taken to insure continuous operation of U. S. pipe lines

. . . IF ALL-OUT WAR SHOULD COME!

Along the lines . . .

1. **Provide security guards at all important points such as river crossings and vital junctions.**
2. **Install security fencing (even concrete or earthen walls) at junctions and block valves to make them less accessible and to ward off hand-thrown explosives and small-arms fire.**
3. **Increase air and ground patrol along the line.**
4. **Set up a formal reporting system with owners or residents along the line. These people are usually alerted to almost any unusual occurrences.**
5. **Equip each line with monitoring instruments to detect any abnormal operating conditions.**
6. **Shield structures above the ground with concrete walls or earthwork embankments.**
7. **Remove visible evidence, wherever possible, of the route of the line, and camouflage vital spots.**

By C. B. LESTER, Mid-Valley Pipeline Company, Longview, Texas, and **H. T. CHILTON, JR.,** Service Pipe Line Company, Tulsa

THE PIPE LINE industry has always been noted for its ability to take care of any emergency. In a normal year, lightning will strike tanks, fires will break out in pump stations, leaks and breaks will occur in high-pressure lines. Yet the lines are back in operation in a short time.

The differences in these emergencies and those caused by an enemy attack will be a matter of degree. There will be more emergencies and, directed by a thinking enemy, they can be expected to occur at the most important installations on the most important lines.

Basic considerations. Action of an enemy can be resolved into three phases. Each of which presents a different security problem.

1. Sabotage
2. Air attack
3. Land invasion.

A pipe line system can be divided into three types of installations, each of which presents a different security problem.

1. Pipe lines
2. Pump stations
3. Tank farms

Pipe line vulnerability. Pipe lines can never be protected fully against sabotage. One man with a shovel and a stick of dynamite can shut down a long stretch of line. Important points can be guarded but you can never continuously guard an entire pipe line.

The lines are difficult targets from the air because they are narrow and buried in the earth—and earth cover is the best natural defense against any kind of explosion. Therefore, pipe lines should be relatively safe from bombing or from the action of distant guns during any possible land invasion.

Once an enemy has over-run an area in which pipe lines are located the problem will be to destroy the lines so that they will not be of any advantage to the enemy.

Pump station vulnerability. A pump station on the other hand is a heavy concentration of valuable equipment in a small area. It can be defended against sabotage because sufficient manpower will be available to give it every operating chance.

Protective measures can be taken against air attacks. But none of these can offset direct hits. For example a pump station can be:

- Partly buried, sandbagged, or protected with concrete splinter walls.
- Piping and manifolds can be shielded or mounted with earth.
- The entire area can be camouflaged.

All of these measures make attack more difficult, but they cannot change the unalterable: if a pump station gets a direct hit, it's going to be put out of business—and probably for a long time. The problem then will be to replace rather than to repair.

At pump stations . . .

1. **Enclose the property with security fencing. In vital areas, light this fence and provide guards or guard dogs.**
2. **Shield manifolds and equipment with concrete walls or sandbags.**
3. **Install bypass connections and header gates far enough from the station to isolate it completely in case of fire or other emergency.**
4. **Install fire-fighting equipment, either fixed or heavy-duty portable types.**
5. **Surround all manifolds and building fronts with concrete walls or earthwork embankments. Enclose all buildings not of heavy masonry.**
6. **Partly bury the station and manifolds.**
7. **Camouflage the station.**
8. **Supply all power needs within the station, utilizing fuel from the pipe line.**

At tank farms . . .

1. **Surround the property with security fencing, keeping well away from all tanks and appurtenances. Light and guard this perimeter.**
2. **Shield manifolds and equipment with concrete walls or sandbags.**
3. **Collar the tanks with concrete walls.**
4. **Cover all piping above the ground with an earth fill.**
5. **Partly bury the tanks and provide an earth cover.**
6. **Space the tanks so that one exploding tank will not set other tanks on fire.**
7. **Protect transfer pump houses and appurtenances the same as line pump stations.**

Tank farm vulnerability. A tank farm is a large, easy-to-hit installation. It is not continuous, however, and the loss of one or two tanks should not shut down the system. Thus a terminal presents problems which are a kind of hybrid between those of the line itself and those of the pump station.

This thinking, of course, is tempered by the relative vulnerability of tanks. A thin-walled steel structure—a tank—can be put out of business by bomb splinters, or even by strafing or by small-arms fire. We may strengthen our defenses against sabotage, or partly bury or shield the tanks against near-miss bombs or strafing; but a direct hit on a tank will take it out of commission—probably permanently.

Military designers are consciously concerned with security measures to protect the vulnerable spots on a pipe line. Naturally the degree of protection varies with the location and the importance of the facilities. This should also be true of commercial systems; and any measures used on military pipe lines, in the event of an all-out war, could apply equally to our commercial pipe lines. What are some of these measures? They are listed elsewhere on these pages.

Other security considerations. Avoid overcentralization of administration and massive communications "hubs," which, if lost, would drop major sections of a system. Local loops should be planned so that they can be replaced immediately if lost.

In addition, we should be prepared to:

- Pump backwards if necessary.
- Demolish our own lines completely as a last resort if over-run by an enemy.
- Destroy fuel in tanks and line.

This would mean a complete job—not merely breaking the line in a few places and blowing up the stations and farms, but taking such measures as pumping slugs of concrete or heavy mud into the lines at irregular intervals, loading the lines with contaminants to prevent later use, and taking out major river crossings.

Emergency maintenance. Obviously, we can never make a pipe line system secure to the extent, let us say, that we can make a command headquarters secure. We cannot hide it; we cannot fully shield the line from sabotage; we cannot protect the station facilities or tanks from direct hits; and, furthermore, serious damage to our facilities will probably result in a hazardous spill, fire, or explosion.

Therefore, we must prepare ourselves to be sabotaged, bombed, or otherwise temporarily put out of com-

mission—then to restore service as fast as possible.

In this type of emergency maintenance, pipeliners have no peer. But if we are to handle many breaks on a continuing basis, we must plan our steps well in advance.

Above all, we must have skilled and resourceful maintenance crews strategically located with the best available transportation, work equipment, communications, and methods. We must have adequate and easily installed repair materials and equipment.

Stockpiling emergency repair materials and equipment for one company, with any degree of completeness, can represent a very sizable expense. However, because the emergency maintenance problems which face one company usually face another, it appears that the most economical solution would be for pipe line companies operating in the same area to contribute jointly toward emergency stockpiles to meet their common needs.

Stockpiles of engine-driven temporary pumping units are a *must*. We can lose a pump station if it gets knocked out, or if the power system feeding it can no longer deliver. In fact, loss of a power system can put a pipe line out of operation without its ever being touched.

Anyone who has ever pondered over having to provide emergency pumping equipment for a 5000-horsepower pump station can see immediately the magnitude of this problem. Ten 500-hp portable units, with their prefabricated manifold set, would take care of one station. But suppose four stations served by one power system lost their entire feed? We can handle these problems no matter how jury-rigged the replacements are, but planning and timing are extremely important.

A group of companies could stockpile spare river crossings of heavy-wall grade "A" pipe which could be welded and pulled across without weighting or coating. These would in no way be permanent crossings, but they would put a line back in service immediately. An isolated system not already so equipped might well consider going ahead and constructing a duplicate crossing.

Stockpiling of large tanks should not be a major consideration. We can temporarily replace them with smaller 5,000-barrel or 10,000-barrel bolted tanks at a much lower stockpiling cost, and much faster than replacing them with large welded tanks.

Duplication of facilities is a problem without an answer. A 20-inch gasoline line can be forced to 300 million barrels per day under wartime conditions; a 30-inch line in the news a year ago could handle about three times this amount. Yet, recognizing the tremendous capacities of these big products lines, we wonder what a determined group of saboteurs could do to them! Obviously duplication would not save them; it would merely double the enemy's task.

What to do. By now it should be evident that military security for commercial pipe lines poses problems with many pros and cons. Even if war occurs, we do not expect to be invaded or subjected to the enemy's tactical air forces. But we must expect the action of strategic bombers and organized sabotage. If we cannot completely stop the enemy, we can certainly make his work more difficult by taking certain preventive measures, and we can make his work less fruitful by providing the ability to make quick repairs and replacemetns.

Some security measures which could be considered mandatory in wartime also have definite peacetime advantages. Some of these are: installing piping for the isolation and bypassing of damaged pump stations; installing VHF communications which could be used point-to-point to replace primary communication circuits; stockpiling or providing spare river crossings; stockpiling portable pumping equipment; providing looped systems in critical spots; and planning emergency interconnections with other carriers. If such measures are considered in the light of wartime operations, perhaps we will find that we can afford more of them.

Above all, we must be able to repair or replace, and do it quickly. This must include stockpiling of essential gear. The economics of stockpiling favor joint participation between companies operating in the same area.

To formulate and partly carry out a joint stockpiling plan during peacetime has many advantages over stockpiling by individual companies. To make such a plan operational in wartime would certainly be a worthwhile contribution to national security because ability to restore operations quickly, whatever the cause of interruption, is the most valuable and practical security measure.—**The End**

ACKNOWLEDGMENT

This article abstracted from a paper entitled "Wartime Security Measures for Pipe Lines," presented at the Sixth Annual Spring Products Pipe Line Conference and Field Trip under auspices of API Division of Transportation, Edgewater Beach Hotel, Chicago, May 16, 1955.

About the Authors

H. T. CHILTON, JR., joined Service Pipe Line Company in 1947. He served as oil traffic engineer and division chief engineer in the West Texas division, senior engineer in the Tulsa office and assistant to the vice president of operations. Recently named maintenance superintendent, he holds a B.S. degree in mechanical engineering and a B.A. degree in business administration from the University of Texas.

C. B. LESTER studied electrical engineering and physics at Purdue University and the University of Chicago. He was employed by The Standard Oil Company (Ohio), in 1944. He was head of Sohio Pipeline Company Research and Development department when, in 1950, he was transferred to Mid-Valley Pipeline Company as chief engineer.

FIGURE 1—McGaw pumping station at Athens, Tenn.

Plantation Pipe Line Company reports on . . .

Five Remotely-Controlled, Unattended Pump Stations

By T. V. BOCKMAN and R. S. CANNON
Plantation Pipe Line Company

PLANTATION PIPE LINE COMPANY has in operation five remotely-controlled, unattended, electrically-powered pumping stations. The stations have proved satisfactory and the company plans to build more in the near future.

But they can be improved. Operating experience has pointed up desirable design features for such stations, the equipment which needs improving and necessary maintenance procedures.

Design for maximum safety. An unattended station must "think for itself" and must try to protect not only itself but its neighbors from the hazards it may introduce. Good design can make the protection job much easier. For example, an outdoor pump station is practically defenseless against wind-blown sparks from a forest or grass fire. It is highly desirable to house the pump and all small valves, piping, and other equipment which might leak products in a good substantial building with a concrete floor, drained to an underground sump tank.

This building should have an exhaust fan, and air should be drawn in through nonflammable filters. A further precaution against exterior fires, which seems worthwhile, is a strip of concrete pavement extending at least 25 feet around the building, with trees and brush cleared out for 150 feet or more away from the building.

Confining all leaks inside a building, where they can be drained to a sump tank, also provides another protection. A float switch on the sump tank operating on high level can shut down the station and close station valves, thus preventing product from spreading over the countryside in the event of a bad leak.

All equipment and wiring in the pump building should, of course, be designed for class No. 1, group "D" service. Whether the main motor should be explosion-proof or enclosed force-ventilated may be debatable, but it is certainly true that the explosion-proof motor does not require any additional gadgets—which could fail—to make it safe, as does the force-ventilated type.

Because it is not practical to make the station control equipment and switchgear explosion-proof, explosive vapors must be kept away from it. If the control gear is placed in a room adjoining the pump room, additional equipment is required to maintain a pressure differential between the two rooms and to check for explosive mixtures in the control room. At little or no additional expense the control gear can be located a safe distance away from the pump area, either out of doors or in a separate control building. Preference is for a separate control building, 50 to 150 feet away

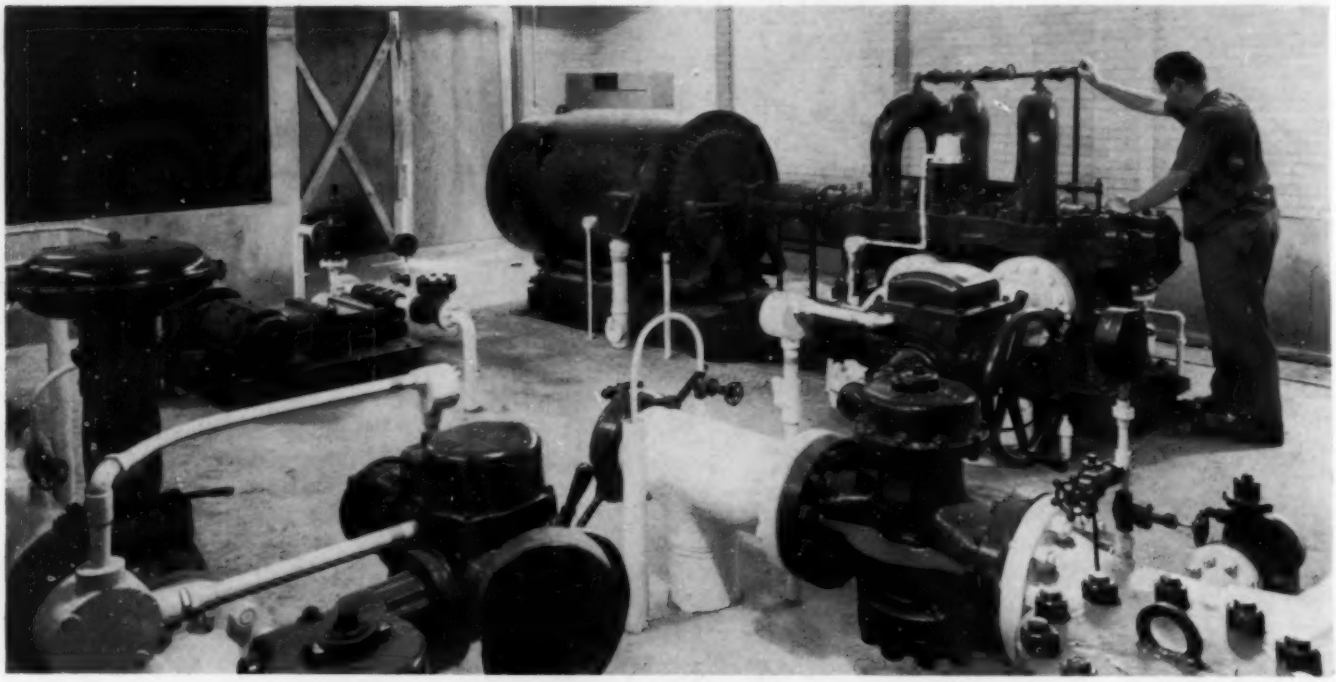

FIGURE 2—Smith station pump building during construction.

from the pump building, depending upon relative elevations. Troubles always seem to develop on cold rainy nights, and it is a bit difficult for the electrician to concentrate on a complicated wiring diagram and hunt for trouble when he is wet and cold.

Recommended layout. Figure 1 shows the general layout of one single-unit station remotely controlled over a microwave link from an attended station approximately 50 miles upstream. Two such stations are located on an 8-inch branch line from Bremen, Ga., to Knoxville, Tenn., and both have been in operation approximately two years. The small building in the foreground houses the radio equipment, channel multiplexing equipment, and a 6-kw standby diesel generator. In the larger building on the right are the main pump (800 hp), 5-hp sump pump, and all station valves, piping, and the like, as shown in Figure 2. The control and switchgear equipment is located in the building to the left. In the background can be seen the incoming and outgoing station block valves, near which are located the electrical pickups to detect passage of scrapers.

Equipment in these stations has, in general, been satisfactory. However, there are some changes, as will be discussed later, which we feel would be desirable. The arrangement of buildings and the layout of equipment we still feel is safe and about as good as any other unattended stations we have seen.

Equipment test. In our opinion no equipment is too good for such an application. An unattended station is certainly no place to economize by using "dime-store" gadgets. Even after purchasing the best equipment available, a lot of grief can be avoided by testing it—not just a simple final sequence test, but a thorough check and test of each individual component. Of course, all reputable equipment is guaranteed, but it would be small comfort, after blowing up a $250,000 station because of failure of a $25 relay, to find that the manufacturer will gladly replace the relay, provided you send him the old one back freight prepaid and install the new one yourself. The manufacturers of the mechanical equipment are not blameless either. One of our pumps, specified to be tested at 2000 pounds and bearing a name plate stating that it had been tested to 1500 pounds, leaked through a sandhole in the case at 500-pound pressure.

We have not actually blown up a station, nor even set fire to one, but we have had some things happen which, with other types of station design or under different circumstances, could have resulted in serious damage.

Recommended equipment changes. Lubricated plug valves were used for motorized station and pump valves. Inasmuch as most of these stations are on lateral lines and make frequent starts and stops, a utility man has to make two to four trips a week to the unattended stations to lubricate the valves. Unless some satisfactory means of automatic lubrication can be devised for the plug valve, a nonlubricated type of valve would seem preferable.

On the first four stations, the pressure controllers used have hydraulic-pressure sensing elements. At the last station built, electrical strain-gage pressure-sensing elements were used to power the pneumatic controller. The electrical system is more accurate and requires less maintenance. Further it eliminates small product piping which is always a source of leaks and other troubles. As for the pneumatic controller and air-operated throttle valve, an all-electric controller and throttle valve are needed. In spite of elaborate precautions such as compressor aftercoolers, moisture traps, filters, and the like, frozen air lines to the throttle valve in the winter are still a problem.

Small product lines are a constant maintenance problem. They leak and they plug up with scale. Some of the station emergency-shutdown devices, such as high and low pump suction pressure, and high outbound-line pressure, are dependent for operation on the small product lines. This is a weak link in the protective system. Something more reliable is being sought.

Some of the scale which plugs up

the small product piping could be kept out by adequate filters. However, it is felt that these would only create an additional maintenance problem, only simple strainers are used to protect the main pumps. Difficulties have arisen with wire bristles lost from scrapers. Occasionally one of these will go through the strainers and pump and will lodge in the station throttle valve, causing the valve to stick. Experiments have been made with a magnetic device to install in the strainer to catch the stray scraper bristles.

To prevent surging of the line and overloading of the motor during the line-packing period, flow controllers were installed at the first four stations. These use differential-pressure electrical strain-gage sensing elements across orifice plates, and the small piping to the differential-pressure cells has a source of leaks. Furthermore, this system complicates the main-station piping because of the necessity of installing straightening vanes and straight runs of pipe above and below the orifice plate. On the most recent station, a load controller, operating on main motor loading, was substituted for the flow controller. Where it is not necessary to telemeter flow back to the control point, it is felt that the load controller is preferable to the flow controller. The load controller costs less, requires less maintenance, and has the further advantage that it will permit more flow on light products.

Supervisory control and telemetering. Plantation has two small stations, each with one 300-hp main pump, operating without supervisory control. These are on 4-inch branch pipe lines. Remote start and stop is accomplished by dialing over the teletype circuit, and no intelligence of any kind is brought back to the control point. However, the control point in both cases is the originating point for the line so that the operator, by watching his pressures and flow, can tell when the remote station is operating. Even for such small and relatively unimportant stations, it is felt that some sort of simplified supervisory control and telemetering of at least station suction and outbound-line pressures is desirable.

On two single-unit 800-hp stations on an eight-inch lateral line, Plantation went overboard on supervisory control and telemetering, and wound up with this equipment costing us

FIGURE 3—Microwave equipment at Bremen station.

$38,000 per station. Experience has shown that some of the intelligence brought back to the control point from these stations is not necessary and that, by grouping some of the fault indications on the same supervisory point, the cost of adequate supervisory control and telemetering for a single-unit station can be brought down to less than half of the foregoing figure.

Transmission of supervisory intelligence. The problem of whether to purchase microwave radio or to lease telephone circuits for transmission of intelligence for remote control of an unattended pumping station is not, in our opinion, susceptible to a general solution applicable to all pipe lines. Plantation has both microwave and leased-wire control and finds that both give better than 95-percent reliability. At the present time it is felt that, for our system, the leased wire is the most practical and the most economical. However, where there is a legitimate use for the additional channels which can be added at very little expense on the radio, there would undoubtedly be applications in which the microwave would be preferable.

Figure 3 shows a view of the 2000-megacycle microwave equipment—with doors removed—installed at the Bremen station, the originating point for the 152-mile radio system operated by Plantation Pipe Line Company.

The center unit in the front row is the main radio frequency that on the left the standby RF, and the unit on the right contains the channel multiplexing equipment. The cabinet in the rear contains control for the standby diesel generating unit (located in another room), tower lights, building lights, radio-fault annunciator panel, and radio remote-control panel from which the standby generators at all remote radio stations can be test started and the radio itself can be switched from standby RF to main RF at any of the remote stations.

In Figure 4, which shows a portion of the control room of the Bremen station, which is manned, the second wall panel on the left shows the station diagram, control buttons, and indicating lights, and the pressure gages and flowmeter for any unattended station located approximately 50 miles away. The small black panel, barely visible below the white station-diagram panel, is a duplicate radio fault-indication annunciator to the one in the radio building (Figure 2). Although this serves to advise the operator of any radio faults, its main purpose is to advise of tower-light outages at all radio stations, as these must be reported as soon as possible to the Civil Aeronautics Authority.

Maintenance procedure—radio. Inasmuch as we have only 152 miles of microwave radio, with seven radio stations (of which three are repeaters), Plantation does not have a radio department. The company has one combination electrician and radio technician, with a helper, who take care of normal maintenance on the radio and also the electrical maintenance of two unattended and one attended pumping stations along the route of the radio. Radio-tower maintenance, including lamp changing, is contracted. The two men have a panel truck assigned to them to carry their tools and the usual instruments necessary for radio and electrical maintenance. In addition to the three aforementioned stations, these men look after the radio equipment at three repeater stations located along the 152-mile route. Also, these men maintain two sets of carrier equipment used to control an unattended booster station on the main line 26 miles from headquarters. This audio

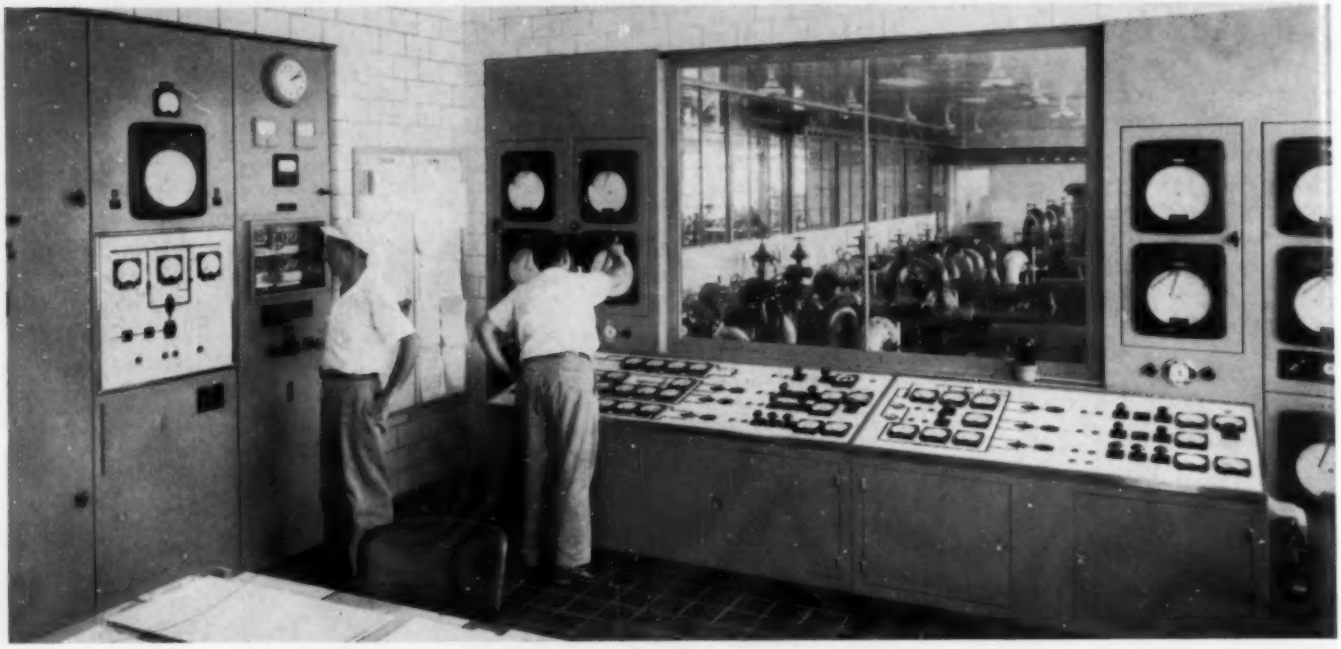

FIGURE 4—Bremen station control room.

carrier is used to multiplex a leased wire, voice grade circuit over which the station is controlled. It includes two channels for supervisory control (with automatic transfer), four telemetering channels, and two channels for emergency start or stop (in case of failure of supervisory control). The carrier equipment was placed in service in September 1954, and to date has required no maintenance.

The radio system has been in operation since September, 1953. During the first four months of operation the manufacturer of the equipment furnished a technician for trouble shooting and to train maintenance personnel. Since that time company maintenance men have been entirely on their own, and the system has not been out for longer than two hours up to now.

Having complete standby RF equipment at each location has been of great help; otherwise, the system would have been useless at least 25 percent of the time. However, it is felt that company men, with no previous electronic background at all, have done an outstanding job in keeping up the equipment. Two different means of voice communication between all locations have been a help in maintaining the system. One of the voice-communication devices is a clear-channel voice telephone which is connected between the division office and all the pumping stations; the other is a service telephone which is connected between all the radio buildings of the system. This service telephone operates over the radio alarm and control channel.

In addition to the radio equipment, these men service the batteries for the auxiliary power plants in the radio buildings and the batteries for the switchgear, make adjustments to pressure and flow controllers and protective pressure switches, and assist in switchgear repair work. Their radio work includes checking the output and frequency of each station, changing out filters in the cooling-air system, and keeping the equipment clean and in good operating condition.

Plantation has had the usual number of tube failures, blown fuses, burnt-out resistors and capacitors, and open circuits in relay coils. Tube life has not come up to expectations; in the past year $1600 worth of tubes of one kind alone have been replaced. A few troubles have cropped up which were a little out of the ordinary. At one of the tower coaxial cables a hole about the size of a .32-caliber bullet was found in the shield, and the area around the lower tower lights was peppered with buckshot. Evidently one of the natives objected to the red lights so close to his home. At another location the signal was interfering with a VHF radio system located on an adjacent forestry tower. Moisture in the coaxial cables on the towers has caused a great deal of trouble and the

FIGURE 5—Switchgear for unattended station.

tower maintenance crew a lot of work in changing out gaskets at coaxial-cable joints.

Radio operation in general, however, has been good, and a large part of this is attributed to the excellent maintenance the crew has been giving the equipment. The system is an easy one to learn and can be worked on with a minimum of trouble.

Maintenance procedure—mechanical. The division mechanical crew, consisting of a foreman and three mechanics, takes care of the mechanical maintenance at the remotely controlled stations in addition to the other stations in the division. This group is responsible for the repair of pumps, air compressors, water pumps, and valves, and for the mechanical repair of the 800-hp pumping motors. Their repair work on the 800-hp motors includes replacement and fitting of bearings as necessary, checking alignment and spacing, and replacement of worn oil rings. This group travels in a truck with a special panel-type body capable of carrying a complete rotating element for the large pumps and all other repair parts necessary for their work.

In addition to the foregoing items, the mechanical group services the seven diesel engines used to drive the 6-kw emergency power generators in the radio buildings. On the original installation we did not have purchased power at two of the repeater stations, and two diesel engines were installed, one running continuously with automatic transfer to the standby unit in case of failure of the normal engine or generator. This installation proved troublesome, as the engines used a large quantity of oil and several of the generators failed.

We have since installed a new type of generator at all locations and have obtained purchased power at all locations. This has greatly reduced the maintenance costs at these locations, as it has eliminated a trip to these locations every ten days to check the diesel-fuel storage tanks, diesel engines, and generators.

Mechanical maintenance record has been very good. It has been necessary to replace one 800-hp motor at one of the stations because of an explosion seal working loose and throwing a whip in the rotor shaft. This was blamed on a manufacturing error and not the result of poor maintenance.

R. S. Cannon

T. V. Bockman

About the Authors

R. S. CANNON received a degree in electrical engineering from the University of Illinois in 1926. After attending a Westinghouse graduate student course, he worked in the electrical drafting and design department of the Pennsylvania Railroad, and in the distribution department of the Mexican Light and Power Company. For 20 years he was with Creole Petroleum Corporation in Carca.

T. V. BOCKMAN was graduated by the Georgia Institute of Technology in 1943 with a B. S. degree in electrical engineering. After serving in the Army, he joined Plantation Pipe Line Company as an electrician in 1946. Since 1948, he has been electrical foreman of the central division, responsible for maintenance and construction work for pumping stations, delivery terminals and microwave.

We have had the usual pump mechanical-seal trouble caused by welding beads, scale, and dirt from new sections of pipe line adjacent to the stations. This could be foreseen from experience on other stations on a new line. Some difficulty was experienced with hydraulic nonslam check valves, between the suction and discharge of the pump, failing to close after a scraper run when the pump was restarted. After eliminating the nonslam and hydraulic features of this check valve, we have had no further trouble. We have had no other unusual mechanical problems.

It is necessary for the mechanical and electrical departments to work together very closely on maintenance at a remotely controlled station. One department can often make repairs to the other department's equipment without calling out their men to make a special trip to the location. This has proved advantageous in the past because, even if one department cannot repair the faulty equipment, the knowledge gained by talking to someone who has a good knowledge of how the equipment should operate helps the department responsible to bring the correct equipment to repair the trouble.

Inasmuch as the supervisory control diagram at the attended pumping stations is arranged to distinguish between electrical and mechanical troubles in the equipment at the remotely controlled stations, the job of maintenance is greatly simplified. The trouble lights give a good indication of what is wrong with the equipment before crews leave for the stations. They can then take the necessary repair parts and do the repair work on arrival with no extra trips necessary to pick up parts.

Maintenance procedure—electrical. The electrical crew consists of three well-qualified electricians. These men perform all the major repairs and maintenance work on the four remotely controlled stations, as well as all other electrical work in the division, consisting of six other pumping stations, four terminals, and the division office. These electricians check the oil circuit breakers, pumping motors, auxiliary motors, and other equipment at definite intervals.

As an aid to better maintenance, it was found that keeping a set of equipment cards at the remote station and a duplicate set at our division point helps in scheduling necessary repair and maintenance work without interfering with normal pumping operations.

On these cards is a complete history of each piece of equipment, showing the services performed and its general condition. By taking advantage of seasonal ups and downs in throughput demands, major maintenance can be scheduled at times of less demand for use of the stations.

The equipment at these remote stations is as nearly foolproof as possible. All switchgear is completely metal enclosed and of dead-front construction, as shown in Figure 5. All motors in hazardous locations are explosion-

Continued on Page 29

FIGURE 1—Map-scale control by templates.

FIGURE 2—Sketch master.

FIGURE 3—Stereoscope.

Routing Pipe Lines by Aerial Surveys

Aerial mapping can speed surveys, reduce costs, and provide greater area coverage. The method deserves careful consideration in any mapping program.

By PAUL J. GIBBS, Great Lakes Pipe Line Company, Kansas City, Mo.

IN PLANNING a program of aerial photography for pipe line routing purposes, it is necessary to understand the fundamentals involved. For example, to what degree will the mapping section of the pipe line company be involved and how much is to be let at contract prices to outside sources?

Immediately following the war the cost of a full line of aerial photographic mosaics, including overlay contours and 60 percent overlap stereopairs, ran about $60 a mile. The finished mosaic was corrected for tilt and distortion, and its scale was 1 to 12,000; or 1 inch equaled 1000 feet. The picture covered an area about 9000 feet wide, with contours drawn at elevation interval changes of 20 feet.

Field control was also furnished as part of the finished survey. It is true that the cost is not inappreciable. Yet, when compared to that of the standard ground-survey method, it is in essence quite economical. With far less detail the maps produced by conventional methods cost in excess of $100 per mile, and they certainly did not cover areas 9000 feet wide.

Flight map. The first step in actual application to a specific project is to prepare a flight map for the airplane pilot. It should show the proposed pipe line route and frequently such information as flight altitude, forward overlap, and type of camera.

As a rule, a photographic mosaic or photomap best satisfies the requirements, as the air view and the picture view are approximately alike as seen from the air. When a suitable flight map is prepared, the limits of the area to be photographed are marked on it.

For best results, photography should be made to a scale of 1 to 12,000 (1 inch equals 1000 feet). The resulting picture is 9 inches wide and covers a strip 9000 feet wide with a 60 percent overlap for stereo-analysis and flight altitude limitations not in excess of 3 percent.

Semicontrolled mosaic. A mosaic is made from the photographs and, prior

FIGURE 4—Stereocomparagraph.

From a semicontrolled mosaic (right), the instruments above are put to use to produce the finished product on the next page.

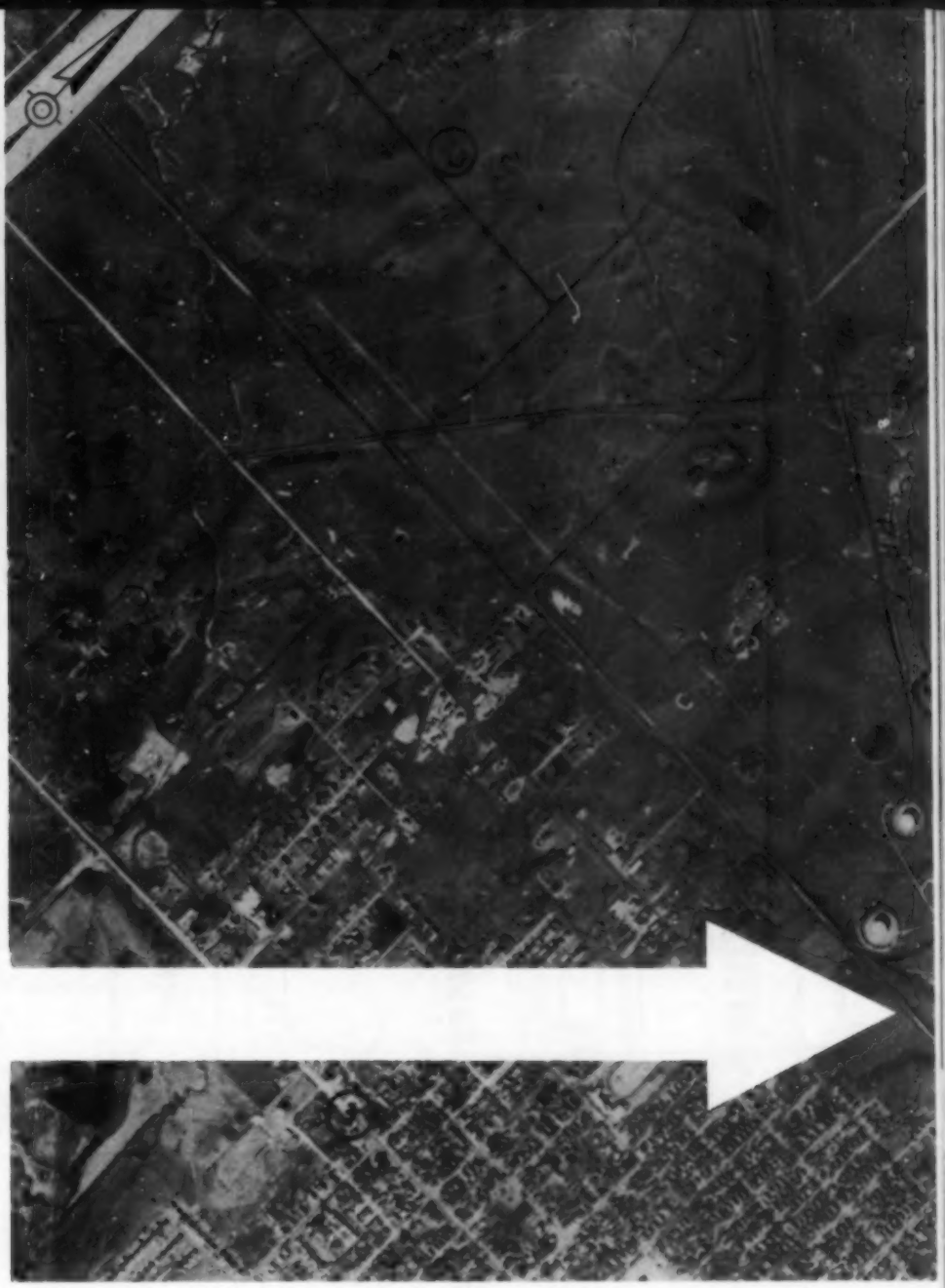

FIGURE 4

to final assembly, is laid out to known linear distances. These known distances should check actual mosaic distances within 5 percent. The finished sheet is known as a semicontrolled mosiac. It is shown in Figure 4. The tear lines, where photographs are pieced together, are distinctly outlined.

It is desirable, but not always economical, to make two parallel flights in congested areas along the route in order to obtain a mosaic 15 inches wide by 36 inches long. Dimensions of this magnitude insure sufficient leeway for reroutes around resolute landowners or bad terrain.

A matte-film negative copy is made from the mosaic photograph. On this film such information as county, range, township, political division, highways, railroads, and principal rivers is listed, in India ink, by the mapping draftsman. Also the route of the pipeline is drawn, following a careful observational and stereoscopic analysis of the terrain.

Thousands of dollars can be saved by a competent engineer who plans routes which will avoid natural obstacles and bad road and railroad-crossing approaches. Substantial economies can also be effected by:

- Providing adequate clearance for the bypassing of urban areas.
- Avoiding, whenever feasible, water sheds for domestic supplies.
- Anticipating future highway construction.

Furthermore, and most important, the pipe line route through private property, which is approximately 99 percent of the right-of-way, can be plotted with enough care to do as little construction damage as is absolutely necessary.

Finished film. The finished film is now reproduced for field use; and, as such, it replaces the planimetric maps previously used. Reproduction is usually by the blueprint method, or on

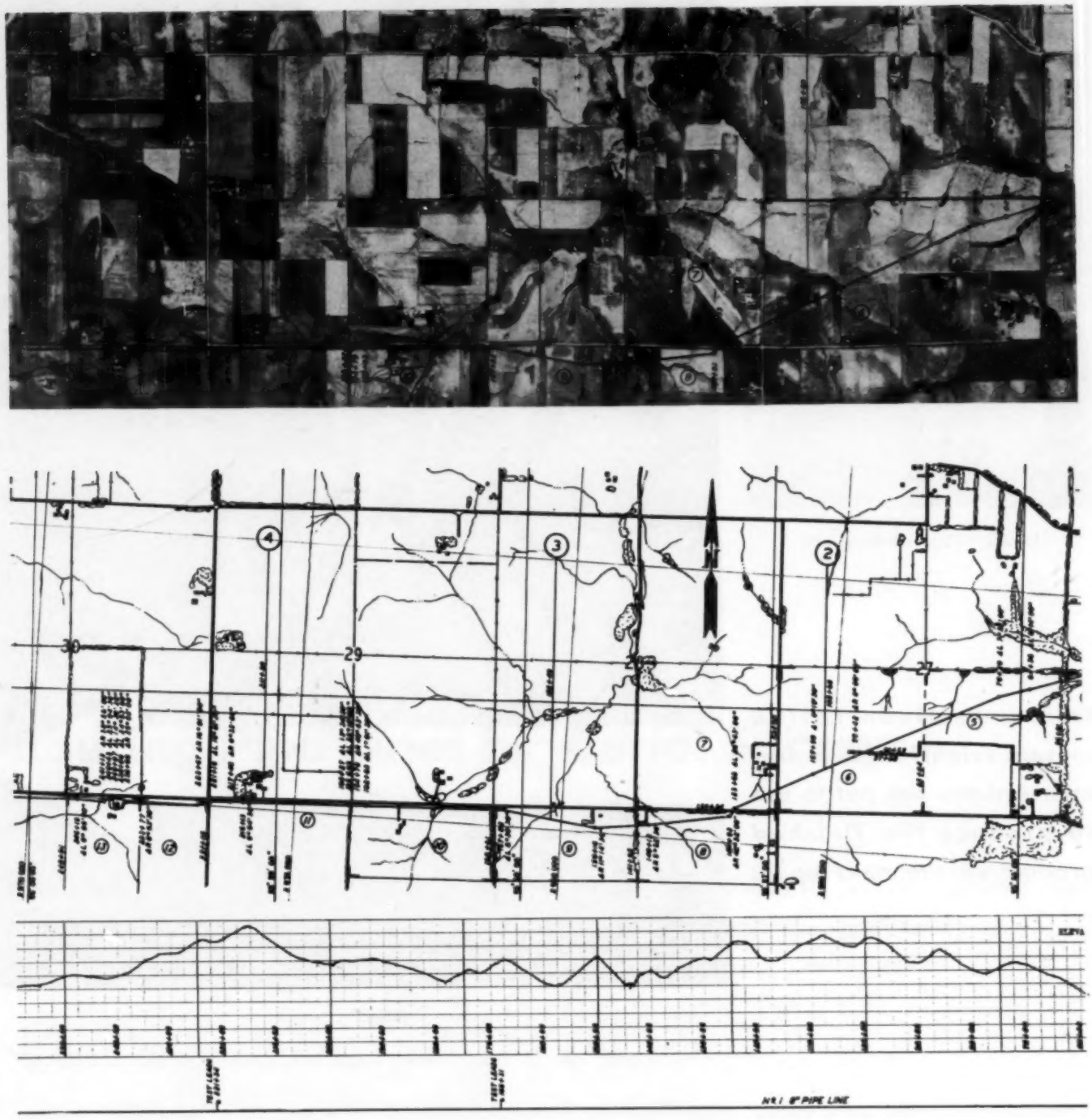

FIGURE 5—Composite alignment map with controlled aerial mosaic.

black and white using other processes. With the reproduction of the photomaps, the job is complete, and construction may now go forward.

Map-scale control. By comparison with accurate ground-survey information, an aerial photograph is not in any sense a map or even an acceptable substitute. Variation in flight altitude —even within the 3 percent limitation established as a standard—when combined with terrain diversity frequently causes scale distortion in excess of 200 feet per mile. Tip and tilt of the aircraft cause the photograph to be slightly oblique rather than a true vertical view of the terrain.

This causes a continuous scale change from one edge of the photograph to the other; and, as a result, image points are displaced from the true map position. It is evident, if we are to make precise use of the detail provided in an aerial photograph, that we must correct distortions in order to show material in its true position. One thing we know about distortion—although this varies in magnitude—is that it is consistent in direction, for the reason that a point on a photograph is displaced from its true position (i.e., from the position it would occupy on a correct map) along a ray originating at the center of the photograph.

By plotting these rays through the center of the photograph and through points which are readily identified, it

is feasible to establish their direction relative to the center point.

We now know that the true map location of these points falls some place on a plotted ray. If the same points are located on the overlapping area of another photo, and if rays are plotted through them to the center of this photo, it is possible, by orienting the theoretical lines of flight, to form correctly a series of intersections of these rays; and these, in turn, will indicate the true map position of these points.

In effect, this is radial triangulation, and it may be accomplished mechanically by the use of slotted templates such as shown in Figure 1.

Sketch master. Thus the true map positions, occupied by control points at intervals as far apart as 15 miles, may be used in conjunction with radial triangulation to determine the accurate map position of any number of points between these control positions.

This can be done by first plotting the map positions of several detail points on each photo, and then projecting the photo image on the base map by using a vertical "sketch master."

Figure 2 shows the sketch master. It may be adjusted until all detail points occupy their previously plotted map positions. This necessarily means the instrument is adjusted until tilt and scale distortion is compensated for, and points under scrutiny fall within the accuracy limits demanded.

The detail may be then sketched from the photograph onto the map in its true geographic position. Maps drawn in this pattern are quite accurate, and include detail which would prove excessively expensive if acquired by ground-survey methods.

Stereoscope and stereocomparagraph. When the map is complete, it is turned over to the routing engineer, who scrutinizes it for the most economical, shortest, and easiest terrain feasible within the limits of the photography. To accomplish this, he makes use of a stereoscope such as the one shown in Figure 3.

On any section of the map where topography is required, equipment such as that shown in Figure 4 is used. It is called a stereocomparagraph; and, although, basically, it is similar to the stereoscope, it does incorporate refinements which permit its use to provide topographic contours.

Composite map. Figure 5 shows a finished composite map all made from aerial photography. It includes a mosaic picture showing the line route; immediately below this is a planimetric map in which the "sketch master" was the principal instrument. Farther down we find a profile which came from topography produced by a stereocomparagraph.

Below the profile is a line diagram which lists information relative to pipe line equipment such as valve locations, cathodic-protection rectifiers, and ground beds. In the lower section is a tabulation of landowners and line data such as pipe weights, type of coating, and survey stations.

Conclusion. To summarize, the advantages of aerial surveying and mapping are substantial; and, as techniques and equipment improve, it is felt that ground surveying eventually will disappear from the pipe line field.

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—The End

About the Author

PAUL J. GIBBS, chief draftsman for Great Lakes Pipe Line Company, has been with the company 24 years. Prior to joining Great Lakes, he attended Colorado College and served with Midwest Refining Company, The Standard Oil Company (Indiana), The Producers and Refiners Company and Shell Petroleum Company.

Unattended Pump Stations

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proof and are of squirrel-cage induction design for safety and ease of maintenance.

No maintenance work is allowed at these locations unless there are two men present. This eliminates the possibility of a man becoming sick or injured and not having any way to let us know his condition so we can get help to him. In two years of operation of these stations we have never had an accident or injury.

For transportation these three electricians use a pickup truck with all necessary tools, instruments, and some repair parts carried at all times. We do not carry repair parts for every trouble possible because, as we have mentioned before, the supervisory control board gives us a good indication of what trouble is present. We can then pick up repair parts at our division warehouse before leaving for the job.

Either the electrical crew or the radio crew can perform minor maintenance work or trouble shooting on the electrical equipment. Whichever crew is closer to the job is sent to clear up troubles and get the pumping units back on the line. It is felt that by not allowing the radio crew to specialize in radio work, we can get more useful service from them, and they will become more familiar with operations as a whole.

Electrical troubles have been of a minor nature in all of the remotely controlled stations. None of the troubles experienced have caused a shutdown of the station for more than a few hours. Included in the minor troubles have been frozen air lines to penumatic pressure controllers, stopped-up tubing lines to protective pressure switches, failure of timing relays in sequence-control setup, blown fuses in the battery and flow controller circuits, and burnt-out coils on breaker operating mechanisms. The time spent in selection of the electrical equipment for these stations, as well as an intensive training program for the electrical maintenance men, has paid off big dividends when it comes to locating and repairing electrical troubles.

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This article abstracted from a paper prepared by T. V. Bockman and R. S. Cannon and presented by Mr. Bockman at the Sixth Annual Spring Production Pipe Line Conference and Field Trip under the auspices of the API Division of Transportation, Edgewater Beach Hotel, Chicago, May 16, 1955.

—The End

How Do Proportional Middle-Distillate Movements Affect Pipe Line Capacity?

Many factors affect the over-all capacity of a pipe line handling these varied products. Converting distillate volume to equated gasoline volume simplifies determination of actual capacity.

By J. R. CHILDS, Trans-Northern Pipe Line Company, Toronto

THE PROBLEM of dividing pipe line capacity on an agreed basis between participating shippers is an operational requirement of Trans-Northern Pipe Line Company which operates a 400-mile, 10-inch products line from Montreal to Hamilton, Ontario, Canada.

The procedures which have been developed to accomplish this division, although not entirely conventional, have been obtained without resorting to higher mathematics. The company's experience with these procedures over the past two years has been satisfactory. They may be of practical assistance to other companies.

Basically the problem consists of determining the restriction in pipe line capacity which occurs because of distillate movements and expressing that restriction in terms of gasoline throughput. The method outlined herein converts the restriction caused by distillate movements to an "equating factor."

To define this "equating factor" further, it is that number which, when multiplied by a petroleum-oil distillate volume, will result in the equivalent volume which can be moved in the same length of time through the whole or any part of a given pipe line system. From the shippers' estimates an "equating factor" is developed for each shipper, applying individually to the volume of distillates which that shipper intends to transport.

Factors considered in evaluating losses.

In developing such an "equating factor," the loss in capacity on which it was based was found to be variously affected by certain factors. Specifically, the following factors were significant in the loss sustained:

1. Volume of distillate: Obviously, the larger the volume of distillate to be transported, the larger the loss incurred as compared to gasoline.

2. Type of distillate: Losses in throughput understandably vary to a large extent depending on the type of distillate submitted for movement. As mentioned previously, these different types of distillate products were divided into two categories.

Distillates of low viscosity, such as stove oil, kerosine, and the like, are classified herein as light distillates; and those of a higher viscosity, such as furnace oil, diesel oil, and the like, as heavy distillates.

3. Distribution: Destination of the various products must be taken into consideration because of the effect which it may have on capacity.

4. Hydraulics of system: To evaluate the effect of the distillates it was necessary to determine their effect on each individual section of pipe line between pumping stations. The problem was simplified to a large extent as the rates obtainable in similar products between the majority of stations on the Trans-Northern system were substantially the same.

5. Weather: Extreme seasonal variation in pipeline operating temperatures, with the accompanying effect on the viscosity of distillates, appreciably affects rates obtainable for distillate movements.

6. Stripping: The availability of strip volumes can appreciably reduce the loss hours normally sustained as the distillate is displaced by gasoline after each oil cycle.

The complexity of covering in any one formula every variable which might be encountered led to a simplified approach. With this in mind, the following assumptions were made:

1. The total volume of distillates submitted is to be pumped through the entire length of the pipe line and delivered to the final terminal in the proper number of cycles.

2. Light distillate and heavy distillates are considered as being pumped separately in order to assess liability for loss hours properly.

About the Author

J. R. CHILDS assisted in construction of the Trans-Northern Pipe Line system during 1952 and organized the dispatching and scheduling departments. Now supervisor of oil movements, he was employed by Shell Oil Company in 1943 and was later transferred to Head Office Dispatching department.

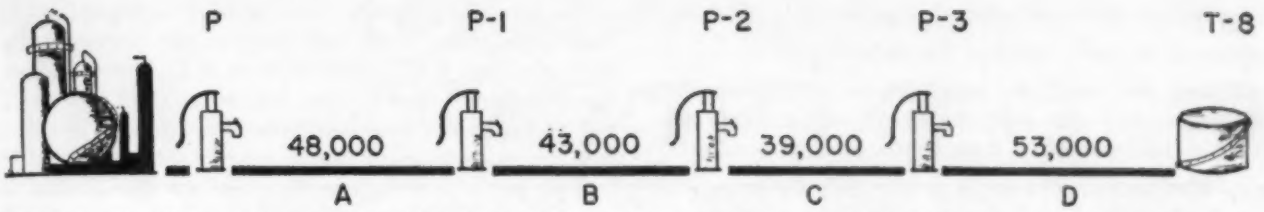

FIGURE 1—Pumping Stations. P—pump station; T-8—terminal; A, B, C, D—sections between Points and distance expressed as volume in barrels.

3. No opportunity exists to reduce loss hours by stripping from gasolines following the distillates.

4. Pumping stations are in approximate hydraulic balance so as to be capable of pumping similar products at the same rate.

Rates. From actual experience at a line temperature of 60° F, basic rates obtainable were 1800 barrels per hour in gasoline, 1600 barrels per hour in light distillate, and 1400 barrels per hour in heavy distillate, respectively. Figure 1 represents a pipe line with actual distance between pumping stations, **P, P-1, P-2, P-3,** and between **P-3** and end terminal **T-8,** expressed as volume in barrels.

Light distillates. Assume that a total of 150,000 barrels of light distillate has been submitted for delivery to end terminal **T-8,** and that the pipe line contains gasoline. A rate of 1800 barrels per hour would be maintained until the moment the light distillate enters the line at **P.** With the displacement of gasoline by light distillate in section **A,** the rate gradually decreases until the light distillate arrives at **P-1.** At this point section **A** is completely filled with light distillate, and the maximum rate obtainable is 1600 barrels per hour. In displacing this initial section the average rate would be 1700 barrels per hour and would require $\frac{48,000}{1700} = 28.2353$ hours. In contrast, if gasolines were the only product involved, the time required to displace section **A** would be $\frac{48,000}{1800} = 26.6667$ hours. Therefore, throughput capacity has been lost to the extent of 1.5686 hours, or (1.5686) (1800) = 2.824 barrels. Inasmuch as station **P** has pumped 48,000 barrels of light distillate, there would remain 102,000 barrels of the original 150,000 barrels to be pumped into the system. The system is now restricted to 1600 barrels per hour. Therefore, the number of hours required to pump this volume into the system would be $\frac{102,000}{1600} = 63.7500$ hours. The number of hours required for a comparable amount of gasoline would be $\frac{102,000}{1800} = 56.6667$ hours. Therefore, an additional 7.0833 hours, or 12,750 barrels of throughput capacity, has been lost during this period for a total loss thus far of 15,574 barrels. At this point the total volume of light distillate is now contained in the line, with the gasoline-distillate interface positioned between **P-3** and **T-8,** and the distillate-gasoline interface at **P.** The rate will be restricted to 1600 barrels per hour until such time as the distillate-gasoline interface arrives at **P-3.** Accordingly, this interface would require $\frac{48,000 + 43,000 + 39,000}{1600} = 81.2500$ hours to arrive at **P-3.** At a gasoline rate, this would only require 72.2222 hours. Therefore, an additional 9.0278 hours, or (9.0278) (1800) = 16,250 barrels of throughput capacity has been lost during this period for a total loss thus far of 31,824 barrels. There now remains only section **D** containing distillate, with the distillate-gasoline interface opposite **P-3.** The average rate to pump the distillate completely out of the line and into the end terminal would be 1700 barrels per hour, and it would require $\frac{53,000}{1700} = 31.1765$ hours. As compared to the time required in gasoline, $\frac{53,000}{1800} = 29.4444$ hours, the pipe line has been restricted 1.7321 hours and has lost an additional 3118 barrels in throughput.

Thus, from the moment that the light distillate enters the pipe line until it has been completely delivered to terminal **T-8,** there has been a total of 34,942 barrels lost in throughput as compared to gasoline.

The volume of loss can be obtained in the foregoing instance by applying the following formula:

$$\left(\frac{2A}{x+ly} - \frac{A}{x} + \frac{V-A}{ly} - \frac{V-A}{x} + \frac{A+B+C}{ly} - \frac{A+B+C}{x} + \frac{2D}{x+ly} - \frac{D}{x}\right)(1800) \qquad (1)$$

Where:

A = distance between **P** and **P-1,** in barrels.
V = volume of distillate submitted, in barrels.
B = distance between **P-1** and **P-2,** in barrels.
C = distance between **P-2** and **P-3,** in barrels.
D = distance between **P-3** and **T-8,** in barrels.
x = gasoline rate, in barrels per hour.
ly = light-distillate rate, in barrels per hour.

Substituting in 1000-barrel units:

$$\left(\frac{96}{3.4} - \frac{48}{1.8} + \frac{150-48}{1.6} - \frac{150-48}{1.8} + \frac{48+43+39}{1.6} - \frac{48+43+39}{1.8} + \frac{106}{3.4} - \frac{53}{1.8}\right)(1800)$$

$$\left(= \frac{96}{3.4} - \frac{48}{1.8} + \frac{102}{1.6} - \frac{102}{1.8} + \frac{130}{1.6} - \frac{130}{1.8} + \frac{106}{3.4} - \frac{53}{1.8}\right)(1800)$$

= (28.2353 — 26.6667 + 63.7500 — 56.6667 + 81.2500 — 72.2222 + 31.1765 — 29.4444) (1800) = (19.4118) (1800) = 34,942 barrels.

Constants. The foregoing formula has its limitations, however, as it would be applicable only when the submitted volume of distillate exceeds the capacity of the two largest consecutive sections in the system. If the volume of distillate does meet this requirement, it becomes evident that certain constants would prevail. For example, the loss of 2824 barrels for displacement of gasoline by distillate in the initial section **A,** and 3118 barrels for displacement of distillate by gasoline in section **D,** would remain constant. In addition, the loss of 16,250 barrels sustained while pumping the distillate-gasoline interface from **P** to **P-3** would be constant. Therefore, there is a primary loss of 22,192 barrels plus a variable

loss dependent on the volume of light distillate. This loss is expressed in the preceding formula $\frac{V-A}{ly} - \frac{V-A}{x}$ Substituting the values for this formula, multiplying by 1800, and adding the result to 22,192 will indicate the number of barrels lost in throughput in light distillates.

Heavy Distillates. Now suppose that 200,000 barrels of heavy distillate has been submitted for delivery to terminal **T-8.** Utilizing the preceding formula, but substituting *hy* in place of *ly* (*hy* = heavy-distillate rate, in barrels per hour), the throughput loss will be:

$$\left(\frac{96}{3.2} - \frac{48}{1.8} + \frac{200-48}{1.4} - \frac{200-48}{1.8} + \frac{48+43+39}{1.4} - \frac{48+43+39}{1.8} + \frac{106}{3.2} - \frac{53}{1.8}\right)(1800)$$

$$= \left(\frac{96}{3.2} - \frac{48}{1.8} + \frac{152}{1.4} - \frac{152}{1.8} + \frac{130}{1.4} - \frac{130}{1.8} + \frac{106}{3.2} - \frac{53}{1.8}\right)(1800)$$

$$= (30.0000 - 26.6667 + 108.5714 - 84.4444 + 92.8571 - 72.2222 + 33.2150 - 29.4444)\ (1800) = (51.7758)\ (1800)$$

$$= 93{,}196 \text{ barrels.}$$

As in the case of light distillate, certain losses in heavy distillate will also be constant. For heavy distillates the primary loss would amount to 49,768 barrels plus a variable loss dependent on the volume.

Light and heavy distillates pumped consecutively. It is now possible to establish the combined loss in throughput occasioned by the movement of both light and heavy distillates if, as previously assumed, they had been transported in individual cycles. However, in actual practice this would be highly impractical for, as will be shown later, losses in throughput would be substantially greater than if both volumes of distillate were pumped consecutively. For this, as well as for other reasons, the number of distillate cycles must necessarily be limited to maintain maximum efficiency of operation. For Trans-Northern's pipe line system it has been found that distillate cycles beginning at intervals of 14 days are compatible with all requirements. In the event that a shipper does not participate in any distillate cycle, and providing his submitted volumes of distillate are not excessive, he is, of course, not assessed for any loss in throughput caused by that particular cycle. Referring to Figure 1, the effect can be evaluated of both types of distillate on the pipe line system as they are pumped consecutively in one cycle instead of in separate cycles. For maximum efficiency the distillates would be pumped in the following sequence: 1, the light-distillate volume; 2, the heavy-distillate volume; 3, a small buffer of light distillate; and, 4, gasoline.

Loss in throughput for the volume of light distillate would be the same as previously indicated until such time as the heavy distillate is introduced into the line at **P.** This initial loss for the light distillate will be 15,574 barrels. Because of the restriction in section **A** caused by the heavy distillate, the rate would gradually decrease until the light-distillate-heavy-distillate interface arrived at **P-1.** The average rate during this interval would be 1500 barrels per hour; the time required would be $\frac{48{,}000}{1500}$ = 32.0000 hours; and the loss in throughput incurred, 9600 barrels.

As previously shown, the system is restricted to 1400 barrels per hour until such time as the heavy-distillate-light-distillate interface arrives at **P-3.** The total loss in throughput up to this point will be 105,745 barrels. The heavy distillate is now contained in section **D.** In displacing this with gasoline the average rate would be 1600 barrels per hour, resulting in a further loss of 6625 barrels. Thus, from the moment that the light distillate enters the line until the heavy distillate has been completely delivered to terminal **T-8,** 112,370 barrels in throughput has been lost.

Comparison of this loss to the total loss when the two types of distillates are pumped separately shows a reduction of 15,768 barrels. This amount will remain constant regardless of any variations in volumes of distillate, but provided that these volumes are each individually greater than the largest two consecutive sections' capacity. If such is the case, the primary loss in pumping the distillates consecutively in one cycle would be:

$$22{,}192 + 49{,}768 - 15{,}768 = 56{,}192 \text{ barrels.}$$

Total loss in throughput for 150,000 barrels of light distillate and 200,000 barrels of heavy distillate would, therefore, be:

$$\left(\frac{LV-A}{ly} - \frac{LV-A}{x} + \frac{HV-A}{hy} - \frac{HV-A}{x}\right)(1800 + 56{,}192) \qquad (2)$$

Where:
LV = light-distillate volume, in barrels.
A = distance between **P** and **P-1,** in barrels.
HV = heavy-distillate volume, in barrels.

Substituting in 1000-barrel units:

$$\left(\frac{150-48}{1.6} - \frac{150-48}{1.8} + \frac{200-48}{1.4} - \frac{200-48}{1.8}\right)(1800 + 56{,}192)$$

$$= \left(\frac{102}{1.6} - \frac{102}{1.8} + \frac{152}{1.4} - \frac{152}{1.8}\right)(1800 + 56{,}192)$$

$$= (63.7500 - 56.6667 + 108.5714 - 84.4444)\ (1800 + 56{,}192)$$

$$= 56{,}178 + 56{,}192$$

$$= 112{,}370 \text{ barrels.}$$

The reason for this reduction in losses is obvious. As soon as a sufficient volume of heavy distillate enters the line, it constitutes the dominant restricting factor and the light distillate, in effect, enjoys a free ride for the remainder of the journey. In an effort to assess liability for losses on an equitable basis, it is felt that the lesser loss for consecutive pumping should be apportioned according to the percentage of the total loss which each type incurs when pumped in separate cycles. On that basis, with a total loss of 112,370 barrels light distillates would be assessed 27.3 percent and heavy distillates 72.7 percent.

Reduction of losses by stripping. An opportunity exists to substantially reduce throughput losses in distillates by stripping off deliveries to intermediate terminals from the gasolines immediately following the distillate cycle. However, this opportunity for increased throughput cannot be taken advantage of until such time as the gasoline arrives at **T-1.** Also, to eliminate entirely the losses which would otherwise be sustained during the period of time necessary for the distillate-gasoline interface to travel from **T-1** to **T-8,** a sufficient volume of gasoline must be available for continuous stripping.

With sufficient strip volumes available during the dis-

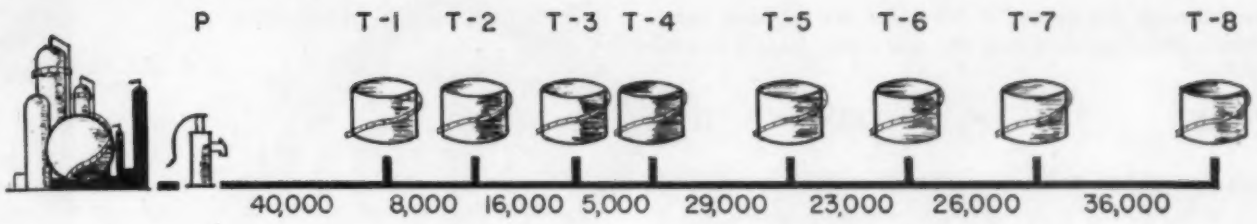

FIGURE 2—Terminals. P—pump station; T—terminals.

placement of the distillates from the pipe line by gasolines, the only loss would be that which occurs from the moment the distillate enters the line a **P** until the gasoline following has arrived at **T-1.** The losses for 150,000 barrels of light distillate and 200,000 barrels of heavy distillate would be as follows:

$$\left(\frac{48}{1.7}-\frac{48}{1.8}+\frac{102}{1.6}-\frac{102}{1.8}+\frac{48}{1.5}-\frac{48}{1.8}+\frac{152}{1.4}-\frac{152}{1.8}+\frac{40}{1.4}-\frac{40}{1.8}\right)(1800)$$

$$=(28.2352-26.6667+63.7500-56.6667+32.0000-26.6667+108.5714-84.4444+28.5714-22.2222)\ (1800)$$

$$=(44.4614)\ (1800)$$

$$=80{,}030 \text{ barrels}$$

In a pipe line system such as that shown in Figure 2, the gasoline strip and tender volumes shown in Table 1 would be required to eliminate loss hours caused by the displacement of distillates by gasolines.

From Table 1 it can be seen that a total reduction in loss hours occasioned by a distillate cycle displacement from **T-1** through **T-8** requires a total progressive gasoline strip of 40,858 barrels and gasoline tenders of 76,858 barrels. If the gasoline strip cannot be made progressively from **T-1** to **T-2,** etc., but can be taken fully at **T-1,** it would require gasoline tenders 183,858 barrels long. However, if **T-1** can meet the minimum strip of 2286 barrels and **T-2** can accommodate the remaining 38,572 barrels of strip, only 175,848 barrels of gasoline tenders are required. Therefore, the minimum amount of gasoline tender required to effect the minimum strip decreases progressively.

Apportioning losses. Assuming that losses amounted to only 80,030 barrels, 27.3 percent—or 21,848 barrels—would be assessed to light distillates and 72.7 percent—of 58,182 barrels—to heavy distillates. Each shipper would liable for a proportion of the losses depending on his volume; i.e., shipper "A" submits 60,000 barrels of light distillate and 80,000 barrels of heavy distillate. Of the calculated light-distillate losses he would be liable for $\left(\frac{60{,}000}{150{,}000}\right)(21{,}848) = 8739$ barrels and $\left(\frac{80{,}000}{200{,}000}\right)(58{,}182) = 23{,}272$ barrels of the heavy-distillate losses. In effect, then, it would be possible to transport 68,739 barrels and 103,272 barrels of gasoline, respectively, in place of the light and heavy distillate. Therefore, shipper "A" would be requested to apply an equating factor to his distillate volumes of $\frac{68{,}739+103{,}272}{140{,}000} = 122.9$ percent.

Evaluating losses for small volumes of distillate. Generally, in the case of Trans-Northern, monthly distillate movements are sufficient to warrant the utilization of the preceding calculations in determining throughput losses. Conceivably, however, the submitted distillate volumes may be so small that, in order to correctly evaluate their effect on capacity, it is necessary to formulate their movement through the pipeline system in a series of progressive displacements.

Rather than undertake the lengthy and somewhat tedious process of evaluating their complete movement through the pipeline, the following approach to the problem is suggested:

Assume, for instance, that only 25,000 barrels of light distillates and 35,000 barrels of heavy distillates have been submitted for delivery to terminal **T-8.** Referring to Figure 1, let us first visualize the light distillate entering the line at **P** and progressing to a point in section **A,** 25,000 barrels distant from **P,** in the interim displacing 25,000 barrels of gasoline. The rate, of course, will gradually decrease as the light distillate progresses into section **A.** The following formula will indicate the average rate during this initial displacement:

$$\left(\frac{Vg+Vgl}{2A}\right)(x)+\left(\frac{Vd+Vdl}{2A}\right)(1y) \qquad (3)$$

Where:

Vg = volume of gasoline in section before displacement, in barrels.

Vgl = volume of gasoline in section after displacement, in barrels.

Vd = volume of light distillate in section before displacement, in barrels.

Vdl = volume of light distillate in section after displacement, in barrels.

Substituting in 1000-barrel units we find the average rate for this initial displacement to be:

$$\left(\frac{48+23}{96}\right)(1.8)+\left(\frac{0+25}{96}\right)(1.6)$$

$$=1{,}331+417$$

$$=1{,}748 \text{ barrels per hour.}$$

Having ascertained that the average rate for the initial displacement would be 1748 barrels per hour, the same is done for the next displacement, bearing in mind the variation which occurs in rate as the heavy distillate now entering the line at **P** displaces the gasoline from section **A.** The following formula indicates the average rate ob-

TABLE 1

Stripping Required to Nullify Displacement Losses

POINTS	Distance Between Points (Barrels)	Gasoline-Distillate Travel Time at 1,400 Bbl. per Hr. (Hours)	GASOLINE	
			Strip Required, at 400 Bbl. per Hr. (Barrels)	Tender Volume Required, at 1,800 Bbl. per Hour (Barrels)
T-1 to T-2	8,000	5.7143	2,286	10,286
T-2 to T-3	16,000	11.4285	4,571	20,571
T-3 to T-4	5,000	3.5714	1,429	6,429
T-4 to T-5	29,000	20.7142	8,286	37,286
T-5 to T-6	23,000	16.4285	6,571	29,571
T-6 to T-7	26,000	18.5714	7,429	33,429
T-7 to T-8	36,000	25.7143	10,286	46,286
Total	143,000	102.1426	40,858	183,858

tained during the period it takes for the gasoline-light-distillate interface to travel the remaining 23,000 barrels to **P-1:**

$$\left(\frac{Vg + Vgl}{2A}\right)(x) + \left(\frac{Vd + Vdl}{2A}\right)(ly) + \left(\frac{Ve + Vel}{2A}\right)(hy) \quad (4)$$

Where:

Ve = volume of heavy distillate before displacement, in barrels.

Vel = volume of heavy distillate after displacement, in barrels.

Substituting in 1000-barrel units we find the average rate for the second displacement to be:

$$\left(\frac{23 + 0}{96}\right)(1.8) + \left(\frac{25 + 25}{96}\right)(1.6) + \left(\frac{0 + 23}{96}\right)(1.4)$$

$= 431 + 833 + 335$
$= 1599$ barrels per hour.

The gasoline in section **A** has been completely displaced by 25,000 barrels of light distillate and 23,000 barrels of heavy distillate. There is remaining an additional 12,000 barrels of heavy distillate to be pumped into the system at **P.** This, of course, will displace 12,000 barrels of light distillate into section **B.** The average rate for this third displacement is dependent upon the section in which the greatest restriction prevails. It can readily be seen that section **A** is the restricting section in this instance as the products contained therein are of higher viscosity both before and after the displacement. The average rate to pump the remaining 12,000 barrels of heavy distillate into the line can be obtained by the following formula:

$$\left(\frac{Vd + Vdl}{2A}\right)(ly) + \left(\frac{Ve + Vel}{2A}\right)(hy) \quad (5)$$

Substituting:

$$\left(\frac{25 + 13}{96}\right)(1.6) + \left(\frac{23 + 35}{96}\right)(1.4)$$

$= 633 + 846$
$= 1476$ barrels per hour.

The next displacement will move the gasoline-light-distillate interface the remaining 31,000 barrels to **P-2.** In effect, this means that 31,000 barrels of gasoline will be displaced from section **B** by the same volume of gasoline entering into section **A.** The average rate during this particular displacement will be dependent upon both sections to a certain extent.

At the beginning of this displacement section **A,** containing the heavier product, will be the restricting section. As this heavier product progresses from **A** into **B** it ultimately reaches a point where **B** instead of **A** becomes the restricting section. It is possible to determine the portion of the displacement of 31,000 barrels which is affected by the product in section **A** simply by applying the following formula:

$$\frac{(A)\ (B)}{A + B} \text{ or } \frac{(48)\ (43)}{91} = 22{,}681 \text{ barrels} \quad (6)$$

Of the 31,000 barrels to be displaced, the average rate for 22,681 barrels of it will be determined by the product in **A,** with the remaining 8319 barrels determined by the product in **B.** The average rate for the first 22,681 barrels can be obtained by applying the following formula:

$$\left(\frac{Vg + Vgl}{2A}\right)(x) + \left(\frac{Vd + Vdl}{2A}\right)(ly) + \left(\frac{Ve + Vel}{2A}\right)(hy) \quad (7)$$

Substituting in 1000-barrel units:

$$\left(\frac{0 + 22.7}{96}\right)(1.8) + \left(\frac{13 + 0}{96}\right)(1.6) + \left(\frac{35 + 25.3}{96}\right)(1.4)$$

$= 426 + 217 + 879$
$= 1522$ barrels per hour.

The average rate for the remaining 8319 barrels can be obtained in a similar manner by applying the following formula:

$$\left(\frac{Vg + Vgl}{2B}\right)(x) + \left(\frac{Vd + Vdl}{2B}\right)(ly) + \left(\frac{Ve + Vel}{2B}\right)(hy) \quad (8)$$

Substituting the 1000 barrel units:

$$\left(\frac{8.3 + 0}{86}\right)(1.8) + \left(\frac{25 + 25}{86}\right)(1.6) + \left(\frac{9.7 + 18}{86}\right)(1.4)$$

$= 156 + 930 + 451$
$= 1537$ barrels per hour.

Correlating the various displacements, the number of hours required to move the gasoline-light-distillate interface from **P** to **P-2** is:

$$\frac{25{,}000}{1748} + \frac{23{,}000}{1599} + \frac{12{,}000}{1479} + \frac{22{,}700}{1522} + \frac{8300}{1537}$$

$= 14.3021 + 14.3840 + 8.1136 + 14.9146 + 5.4001$
$= 57.1144$ hours.

The number of hours required to make the same displacements at a gasoline rate would be $\frac{1800}{91{,}000} = 50.5556$ hours. Therefore, loss in throughput capacity is $(6.5588)(1800) = 11{,}806$ barrels.

Line temperature. The effect of line temperature on the viscosity of distillates, moderate as it may be, must also be taken into consideration when throughput losses in distillates are evaluated. Table 2 shows approximate line temperature for each month of the year along with the rates obtainable in the two types of product at that particular temperature. Calculation for throughput losses in distillates for a specific month are based on the rates as indicated for that month.

Conclusion. Constants can be established for any system from which an "equating factor" can be derived which, in turn, will assist schedulers in apportioning space or capacity in the pipe line.

TABLE 2
Temperature Application to Rates

	Average Temperature (Fahrenheit)	BARRELS PER HOUR	
		Light-Distillate Rate	Heavy-Distillate Rate
January	35	1,575	1,350
February	35	1,575	1,350
March	35	1,575	1,350
April	40	1,580	1,360
May	50	1,590	1,380
June	60	1,600	1,400
July	65	1,605	1,420
August	65	1,605	1,420
September	60	1,600	1,400
October	55	1,595	1,390
November	50	1,590	1,380
December	45	1,585	1,370

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—**The End**

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*REFERENCE: Panhandle Eastern Pipeline Co. article in March 7, 1955, Oil & Gas Journal. Reprints on request.

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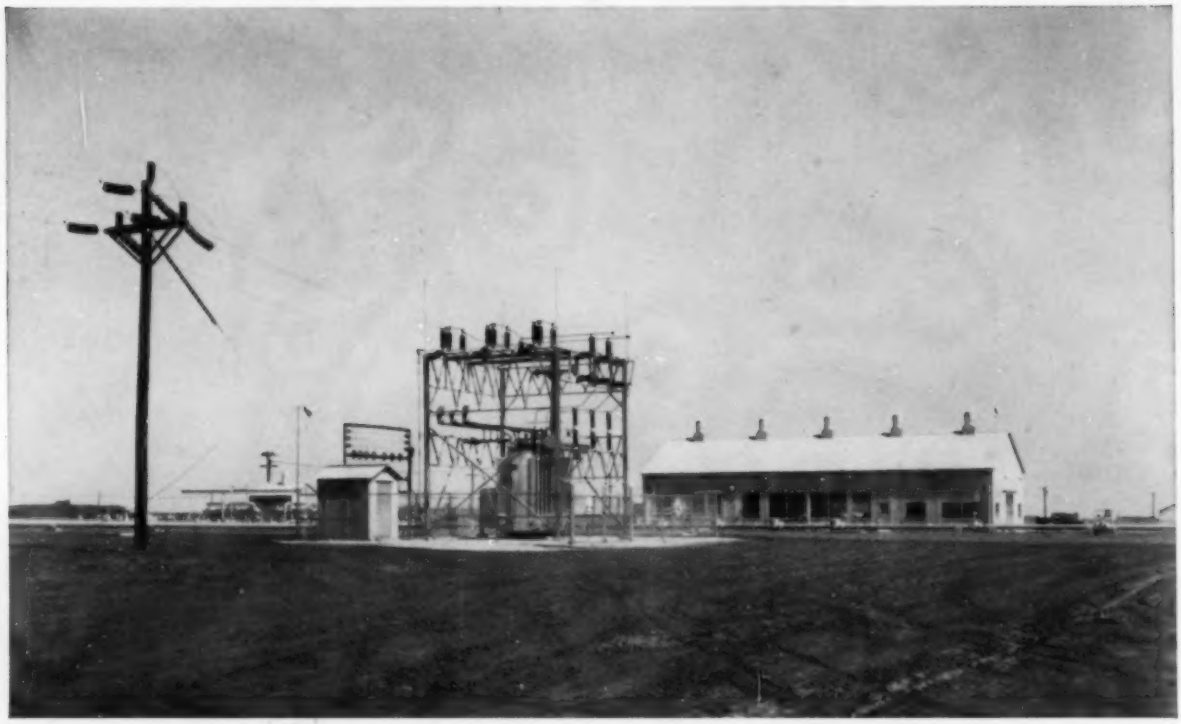

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When Does Cathodic Protection Pay Out?

A survey of 28 leading pipe line companies shows some surprising results as to the cost and pay-out of cathodic protection.

By **DEAN C. GLASS,** Pure Transportation Company, Chicago

This article abstracted from a paper presented at the API Spring Products Pipe Line Conference in Chicago.

FOR A GOOD illustration of the economic factors involved in cathodic protection of a trunk line, take a look at a typical pipe line of Pure Transportation Company. The line was laid in 1930 from Van, Texas to Pure's refinery at Nederland, Texas. It is 10¾-inch pipe with a wall thickness of .307 inch.

The line was laid bare under a 20-inch cover and an 18-mile section of it was subject to alternate wetting that comes with irrigation. In this latter section, ten leaks had occurred by 1938, initiating a "long line current" survey.

It was decided in 1939 to apply cathodic protection to the bare 18-mile section subject to irrigation. An AC power distribution line was laid parallel to the pipe line and 50 small capacity rectifier units were spaced along the route.

Since the protection system was placed in operation in 1940, only eight leaks have developed, the last one in 1948.

Bare pipe section—cost data.

The cost of providing cathodic protection for the 18 miles of 10-inch bare pipe from 1940 to 1955 is broken down as follows:

Installation (1940)	$46,241.45	
Maintenance	67,789.73	
Power	14,922.95	
Total Cost	$128,954.13	
Cost per mile		$7164.12
Cost per mile per year		477.61

Coated section. Since measures had been taken to protect the trunk line in the coastal area, it was decided in 1943 to complete reconditioning, coating and wrapping the remainder of the 186-mile section of 10-inch pipe. This work was completed in 1945 at an average cost of $1.29 per lineal foot of pipe. Total cost of reconditioning, coating and providing cathodic protection for 186 miles for the ten-year period from 1945 to date is:

Coating and Wrapping	$1,267,883.20	
Rectifier Installation	5743.00	
Cathodic Protection Maintenance	3867.71	
Power	6932.96	
Total Cost	$1,284,426.87	
Cost per mile		$6905.52
Cost per mile per year		690.55

As the above is a ten-year actual cost statement for protection of the coated pipe, this data can then be extrapolated for five more years to compare with cost for protecting the bare section for a 15-year period. Assuming that maintenance and power cost will remain constant for five more years, the cost per mile per year is reduced from $690.55 to $462.30. It thus appears that in this case 15 years is the break-even point, after which it will be more economical to protect the coated pipe even though a cash expenditure of $1.29 per foot was necessary for reconditioning and coating.

Survey results. On behalf of the Committee on Pipe Line Technology a survey was made of member pipe line companies to indicate what was being done toward protection of underground structures and costs of such protective measures.

For an economic analysis, there is no known method of estimating uncontrolled corrosion on pipe lines and it

TABLE 1

Pipe Laid Through Period 1930 to 1940
Data Indicating Pipe Line Coating Practice and Cost

Pipe Size	Miles Laid	Percent Bare	Percent Coal Tar	Percent Asphalt	Percent Asphalt Mastic	Percent Wax or Grease	Percent Other	Geographical Locations*	Average Cost† of Coating Per Lineal Foot (Cents)
4"	254	55	0	45	0	0	0	95% SW	....
6"	2352	82	2	11	0	0	5	60% SW—35% MW	19.5
8"	3420	45	7	17	1	2	28	45% SW—50% MW	17.0
10"	740	7	10	76	0	7	0	90% MW	29.0
12"	707	5	0	82	13	0	0	85% MW—15% WC	34.0
14"	15	0	0	100	0	0	0	100% MW	....
16"	5	20	0	0	80	0	0	100% WC	42.0

Of coated pipe listed 99.7 percent was coated over ditch during construction.
* Geographical locations abbreviated SW for south west, MW mid-west, WC west coast, etc., and only areas containing largest percentage of pipe are listed.
† Includes material and application.

TABLE 2

Pipe Laid Through Period 1940 to 1950
Data Indicating Pipe Line Coating Practice and Cost

Pipe Size	Miles Laid	Percent Bare	Percent Coal Tar	Percent Asphalt	Percent Asphalt Mastic	Percent Wax or Grease	Percent Other	Geographical Locations*	Average Cost† of Coating Per Lineal Foot (Cents)
4"	402	61	2	21	0	16	0	63% SE—19% SW	15
6"	1976	15	37	19	20	6	3	55% MW—22% E	23
8"	5652	22	41	19	16	2	0	38% MW—33% SW	29
10"	2538	53	19	21	4	3	0	44% SW—27% MW	30
12"	2622	16	25	50	7	1	1	45% SW—31% MW	37
14"	21	0	12	88	0	0	0	100% MW	..
16"	1028	0	2	98	0	0	0	80% SW—18% MW	44
18"	215	0	0	18	62	0	20	82% WC—18% MW	54
20"	1304	0	50	41	0	0	0	86% MW—14% SW	62
22"	158	0	0	48	52	0	0	100% MW	75

Of coated pipe listed 89 percent was coated over ditch during construction.
* Geographical locations abbreviated SW for south west, MW mid-west, WC west coast, etc., and only areas containing largest percentage of pipe are listed.
† Includes material and application.

is therefore difficult to estimate savings achieved by the preventive measures.

The cost of corrosion prevention indicated in Tables 1, 2, 3 and 4 has been made available by a cross-section of the industry and provides an average cost for coatings and cathodic protection for the years 1930 through 1954 and is based upon line sizes from 4-inch through 26-inch inclusive.

CONCLUSIONS

Principal conclusions based upon an economic survey of Pure Transportation facilities cited are:

1. Based upon 15 years operating experience in the Texas Gulf Coast area it is economically feasible to protect a bare 10-inch pipe line by cathodic protection. Protection is effective as evidenced by the fact that occurrence of leaks has been stopped.

2. The initial investment for corrosion prevention by cathodic protection of an existing line is approximately 50 percent of that required for reconditioning and coating.

3. The initial investment and operating expenses of cathodic protection installations for 15 years equals the estimated cost of reconditioning, coating and supplementing coating with cathodic protection.

4. Many pipe line failures and unnecessary maintenance expenses can be eliminated by proper initial design of facilities.

5. For economic appraisal of various corrosion preventive measures we must consider initial investment, interest, depreciation, operating expenses, percent return on investment and consider engineering and operation requirements as dictated by the specific problem.

6. An essential condition for success of a corrosion preventive program is the proper attitude on the part of company executives. They must believe in the need for corrosion prevention and give financial and moral support.

From analysis of industry survey data indicated in Tables 1, 2, 3 and 4 concerning 63,500 miles of pipe lines laid, it can be concluded that:

1. From 1930 to 1940
   a. 40 percent of pipe was coated (4-inch diameter through 8-inch)
   b. 94 percent of pipe was coated (10-inch diameter through 16-inch).
2. From 1940 to 1950, 78 percent of pipe was coated (4-inch diameter through 22-inch).
3. From 1950 to 1955, 95 percent of pipe was coated (4-inch diameter through 26-inch).
4. From cost data submitted, an average cost of a specific coating cannot be determined due to the number of variable factors.

TABLE 3

Pipe Laid Through Period 1950 to 1955
Data Indicating Pipe Line Coating Practice and Cost

Pipe Size	Miles Laid	Percent Bare	Percent Coal Tar	Percent Asphalt	Percent Asphalt Mastic	Percent Wax or Grease	Percent Other	Geographical Locations*	Average Cost† of Coating Per Lineal Foot (Cents)
4"	326	15	84	0	0	1	0	72% SW—27% MW	21
6"	706	5	77	15	3	0	0	67% SW—21% NW	38
8"	2787	3	71	20	6	0	0	46% MW—27% NW	33
10"	2225	15	68	9	8	0	0	45% SW—43% MW	37
12"	3365	0	85	8	6	1	0	75% MW—24% SW	50
14"	690	13	87	0	0	0	0	66% SE—27% E	...
16"	507	0	74	26	0	0	0	62% SW—19% NW	48
18"	454	0	100	0	0	0	0	95% SE	56
20"	603	0	58	42	0	0	0	72% SW—21% NW	54
22"	379	0	36	64	0	0	0	65% SW—35% NW	56
24"	321	0	12	78	0	0	0	99% SW	58
26"	493	0	100	0	0	0	0	100% SW	50

Of coated pipe listed 92.3 percent was coated over ditch during construction.
* Geographical locations abbreviated SW for south west, MW mid-west, WC west coast, etc., and only areas containing largest percentage of pipe are listed.
† Includes material and application.

5. From Table 4, cost data available indicates that rectifier power cost per mile per year for cathodic protection of coated lines averages $7.12 and the median power cost per mile per year is $4.85.

6. Rectifier cathodic protection power cost per mile per year for bare pipe shows an average of $53.41 and median of $53.90.

7. Indications are that one-half of reporting companies have over 90 percent of their facilities under cathodic protection.

Based upon data for period 1951 through 1953 a survey* of leading yard applicators indicates:

1. 90 percent of customers specify coal tar coatings.
2. 40 percent specify a single wrap of 15-pound asbestos felt.
3. 29 percent specify a single wrap of glass type wrapper.
4. 31 percent specify a single inner wrap of glass type and one external wrap of 15-pound asbestos felt.

* Survey excludes asphalt mastic yards.

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The author has extended special appreciation to O. L. Entrekin and J. A. Wisdom of Pure Transportation Company for suggestions and aid in preparation of the cost data.

—The End

TABLE 4

Summary of Cost Data—Power Cost for Cathodic Protection and Leak Experience

Source of Data Co. No.	Length of Pipe Line System Miles	Percent of System Having Cathodic Protection	Leaks Per Year	Leak Frequency /100 Miles/ Year	Cost/Leak Dollars	†Rectifier Power Cost $/Mile/Year (Coated Pipe)	Rectifier Power Cost $/Mile/Year (Bare Pipe)	Mag. Anode Cost $/Mile/Year (Coated Pipe)	Mag. Anode Cost $/Mile/Year (Bare Pipe)
1	2253.82	17	1207	54.9	432	8.44	8.44	10.00	10.00
2	1172.50	91	0	0	....	2.70	....	.80	....
3	445.00	100	0	0	....	1.20	....	....	....
4	546.00	100	0	0	....	6.62	....	....	....
5	1348.00	38	200	14.9	175	10.60	....	16.30	....
6	9120.00	30	1602	17.6	750	18.00	....	....	....
7	2061.00	82	5	.2	2500*	18.38	22.75	....	....
8	1195.80	....	75	6.3	....	1.00	4.70	....	....
9	763.20	100	1	.1	....	1.22	....	5.67	275.04
10	1578.00	50	....	....	....	....	125.00	....	250.00
	2628.00	100	....	....	....	3.00	....	....	....
	2400.00	....	25	1.0	1600*	....	....	....	....
11	1152.29	....	....	....	....	5.30	....	5.17	....
12	195.00	100	0	0	....	1.10	....	....	....
13	625.00	18	....	....	....	11.18	87.38	....	....
14	573.00	65	130	22.6	130	....	....	....	....
15	98.35	100	0	0	....	3.15	....	....	....
16	9078.00	65	216	2.4	865	....	....	....	....
17	9244.00	31	539	5.4	....	....	46.00	25.00	....
18	268.50	100	0	0	....	.64	....	3.11	....
19	485.00	100	7	1.4	1555*	....	61.80	....	....
20	1043.00	99	1	.1	250	29.50	....	20.00	....
21	2140.00	87	2	.9	1600*	1.20	....	1.34	....
22	427.00	1	20	4.7	300	....	....	....	150.00
	569.00	86	1	.2	300	....	....	10.00	....
	75.00	20	....	....	....	....	....	....	....
23	77.00	100	1	1.3	1350*	6.24	90.00	....	....
24	5313.00	55	165	3.1	1686*	11.43	....	....	161.00
25	414.20	100	2	.5	400	4.39	....	....	....
26	6040.00	45	242	4.0	....	8.08	15.05	47.30	127.50
27	211.00	100	0	0	....	3.33	73.33	....	....
28	.....	100	0	0	....	....	....	....	....

* Indicates product Pipe Lines.
† Data submitted did not indicate line sizes (all data includes 4-inch through 26-inch).

Laying 36-Inch Pipe Just Like 30-Inch

For the first time, this heavy super-inch pipe is being laid in the conventional manner. But welders are using stepladders to reach top of the pipe and a small bull-dozer is handy in crumbing out the bottom of the mammoth ditch.

1 Kittypillar crumbs out the 51-inch-wide ditch. This small bull-dozer followed Houston Contracting Company's rock gang, smoothing the ditch after blasting.

By DONALD M. TAYLOR,
Editor, PIPE LINE INDUSTRY

IN THE PIPE LINE INDUSTRY the No. 1 rainy-day controversy has centered on the best method for laying big-inch pipe. The controversy was touched off last year when Associated Pipe Line Contractors dusted off the oldest technique in pipelining—the sewer-pipe method—and laid 48 miles of 36-inch pipe for Transcontinental Gas Pipe Line Corporation in Mississippi and Alabama.

This joint-by-joint operation requires a minimum of equipment. The pipe is yard-coated before it is hauled to the right-of-way, bent and bell-hole welded in the ditch. This eliminates the lowering-in operation.

Pipeliners who visited the Mississippi spread were astonished at the speed and compactness of the operation. From front to back, the spread was only four miles long. However, in the roller-coaster hills of Alabama things were not so smooth. Progress was not so fast.

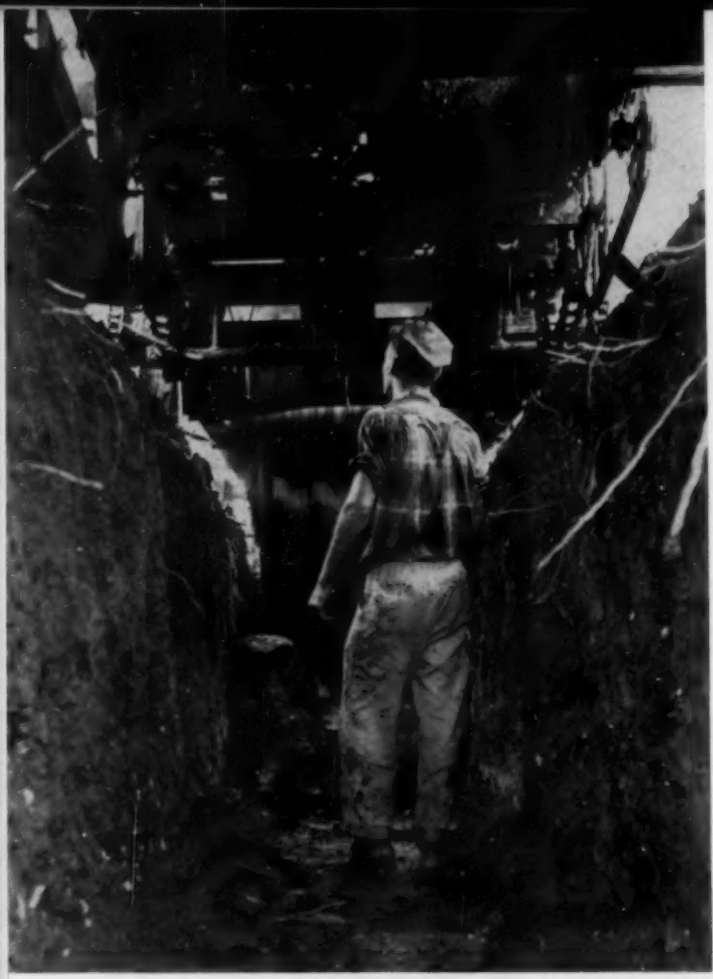
At any rate, pipeliners started taking a new look at big-inch pipe laying methods. And one of the principal arguments favoring the sewer-pipe method was that present day laying equipment could not economically handle the 155-pounds-per-foot 36-inch pipe.

When Transco embarked on its $83 million looping program, which calls for 315 miles of 36-inch, 219 miles of 30-inch and 46 miles of smaller pipe, it set the stage for a settlement of the issue. The six contractors who will lay the 36-inch pipe are evenly divided on the method. Three are using sewer pipe; three are using the alongside-the-ditch method.

The argument that present day equipment could not handle the 36-inch pipe was dispelled at once by Houston Contracting Company, Western Pipe Line Constructors, and Panama-Williams Company. When PIPE LINE INDUSTRY visited the first two spreads, both were geared to a mile-a-day laying rate, using but slightly more equipment than is normal on a 30-inch spread.

So far as the economics are concerned, perhaps only the auditors of the contractors will ever get the true answer.

Continued on Next Page



2 Workman stands in the pilot ditch beneath giant ditching machine that cuts the finished ditch which is 51 inches wide and a minimum of 5 feet, 6 inches deep. Distance between the tracks on this machine was increased two feet to enable the machine to straddle the 48-inch ditch cut by the pilot machine.

Houston Contracting Company spread

HOUSTON CONTRACTING COMPANY is laying about 85 miles of the .406 wall, 36-inch pipe across the hills of eastern Alabama and southwestern Georgia. With time out for rains, the spread has averaged about one mile per day under the skilled guidance of veteran pipeliner W. H. (Snake) Hayes.

Key men on this spread have worked together for years and the entire operation has the deceptive "easy" look which is the mark of the professional.

The primary differences between the laying of 36-inch and laying of 30-inch pipe center around the ditch, the welding, and lowering-in.

The ditch has a minimum depth of 66 inches and a width of 48 inches. Three pieces of equipment are used in cutting it. First there is a pilot ripper which breaks the soil down the ditch line. This is followed by a pilot ditcher which cuts a ditch to partial depth. Next comes the large ditching machine which was specially modified to straddle the pilot ditch. The tracks were spread two feet further apart and the conveyor was lengthened one foot.

There are about 30 welders on this job. Three are on stringer beads, four on hot-passes and the remainder on firing line, tie-ins, valve assemblies, drips, etc. The firing line welders average about 8½ welds per day.

3 Five lowering-in tractors line up a section of the pipe for tie-in at road crossing. Naked pipe weighs 155 pounds per lineal foot.

4 The line-up and tie-in.

5 Pausing at a road crossing near Alexander City, Ala., are (left to right) Houston Contracting Company's Assistant Spread Superintendent Lewis Young, Welder Foreman Oscar Townsend, and Freeman Ueckert, Transco inspector.

6 Old meets new. Georgia native furrows his field with mule-drawn plow unmindful of the big ripper which is breaking the soil ahead of the first ditching machine near Athens, Ga.

Western Pipe Line Constructors' spread . . .

ACROSS THE red clay hills of middle Georgia a Western Pipe Line Constructors spread is more or less duplicating the feat of the Houston Contracting spread 100 miles away. Between the two, there are but slight variations in organization and equipment. Where Houston uses three stringer-bead welders, Western uses four. Western is doubling in brass using the same two tractors on the cleaning-priming and the coating-wrapping operations. Both spreads use six tractors for lowering-in.

One of the unusual things about the cleaning and priming is that the pipe has been pickled and cleans much brighter than ordinary pipe. Some of the pipeliners attributed early trouble with primer bond to this slickness of the metal.

The pipe was pickled inside and out prior to the application of internal coating of epoxy resin. (See March and May issues of PIPE LINE INDUSTRY.)

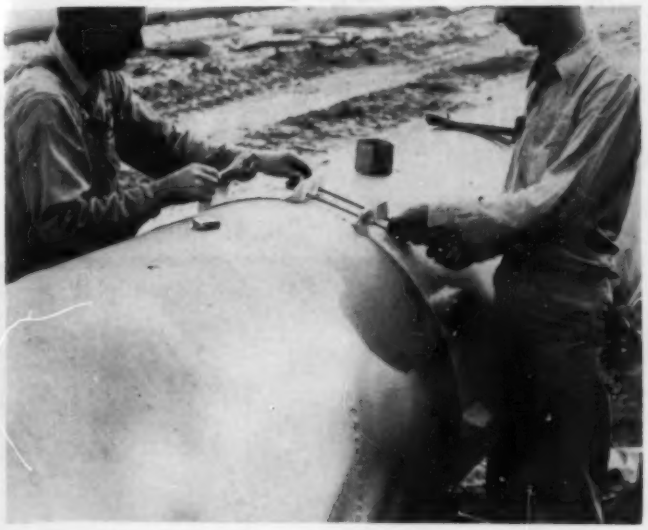
In this regard, one of the first questions asked by visiting pipeliners is—"How much coating is damaged by the weld?" The answer is one-half inch on either side of it.

Pictures Continued on Next Page

7 Hot-pass welders (below) use stepladders to reach the top of the pipe. This is perhaps the first pipe line where the welder helpers had to carry stepladders.

8 Pipe is coated with ⅛-inch of asphalt enamel, fiberglass and kraft paper. Two tractors shown here were able to handle the heavy pipe easily.

9 Six identical tractors lower in the pipe on Western's spread. This operation requires careful coordination because of the heavy weight of the pipe. The tractors seldom get in the position of the one shown here.



10 Insulators are attached to the pipe prior to pulling it into the casing beneath a Georgia highway.

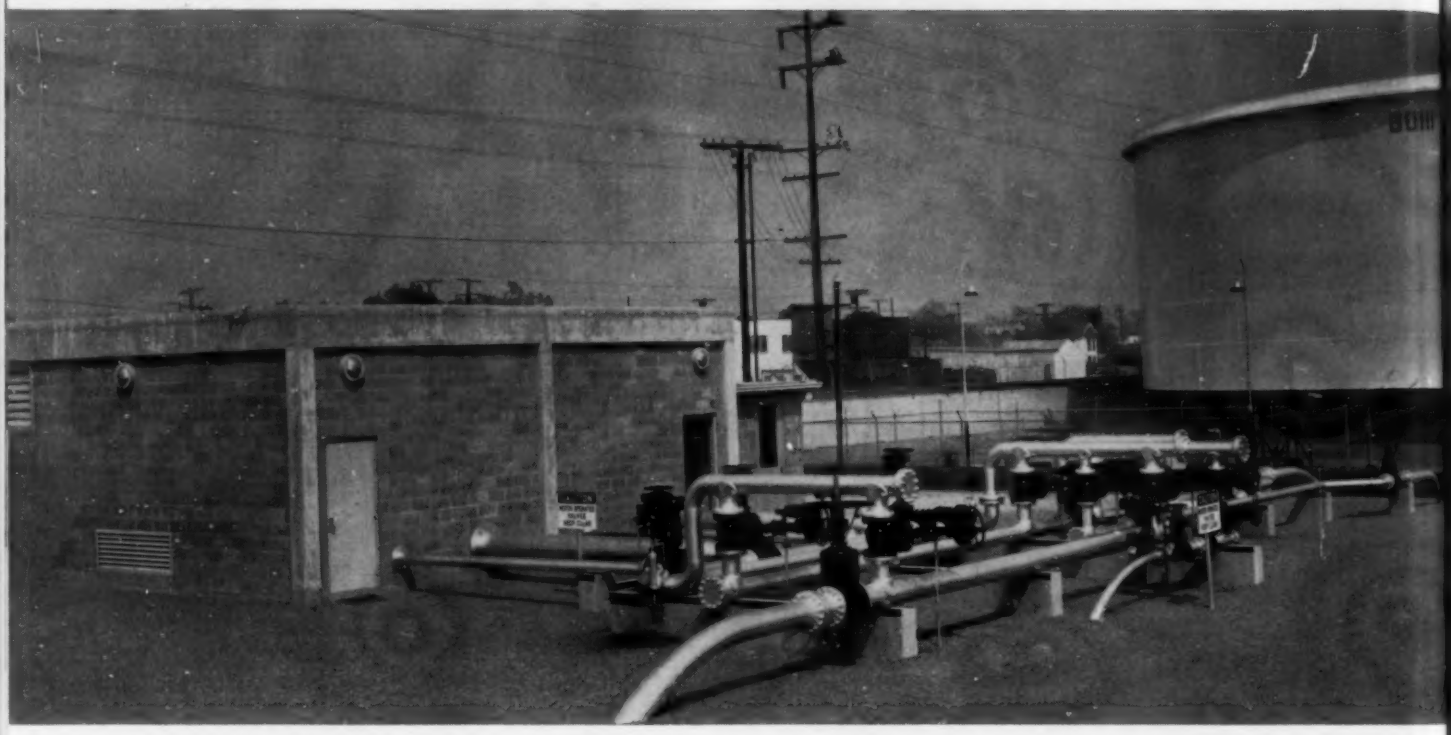
12 Transco Inspector Sam Elgin (above) checks an overbend. He likes for overbends to ride high, sag bends low. He wants the pipe to ride the outside of the ditch on side bends. This provides slack when pipe cools to ground temperature.

11 The crossing is pulled into the casing. Tractor in foreground is pulling. Tractor at upper right is cradling pipe.

13 On Western's spread are (left to right): Spread Superintendent Jack Hodges, Bob Lingle, St. Croix Supply and Engineering Company; M. J. (Whitey) Crose, president of M. J. Crose Company, and Charlie LeNoit, co-partner in Western Constructors.

—The End

Ultra-Modern Unit Replaces 39-Year-Old Oil Pump Station



General view of Norwalk station showing manifolding, air-actuated motor-operated valves, and the 80,000-barrel floating roof storage tank in background. Two lines emerging from wall of the pump house are (1) the 6-inch discharge line from one of the two pumps and (2) shell and tube-type jacket water cooler which is installed on the pump suction line. Heat input to the oil stream reduces crude oil viscosity and helps cut pumping costs. Pump house is sound-proof. Yard lights are turned on automatically by a time clock.

This new station features remote control of gas engine-driven centrifugal pumps, noise abatement, and other automatic operating safeguards.

By J. G. BAIRD, Union Oil Company of California,
and **F. E. SESLER,** Ehrhart & Arthur, Inc.

A THOROUGHLY modernized station with operations completely remote-controlled has replaced a 39-year-old oil pumping plant of Union Oil Company of California at Norwalk, Calif. This new installation, the most recent in Union's pump station modernization program, represents the company's first fully remote-controlled facility and contains features new to West Coast pipelining.

The new station replaces a 1916 steam-powered installation. An economic study showed a complete new station employing gas-engine-driven centrifugal pumps as having advantages over renovation of the existing equipment. The application of remote control further enhanced this advantage.

In modernizing this old station, attention also was given to noise abatement, a number of equipment safeguards, and the separation and disposal of waste water.

Norwalk Station is a part of Union's Southern Division Pipe Line department. This system transports crude oil from producing fields in Los Angeles and Orange counties to the company's Los Angeles refinery. The station operates as a booster between Stewart pump station and the refinery.

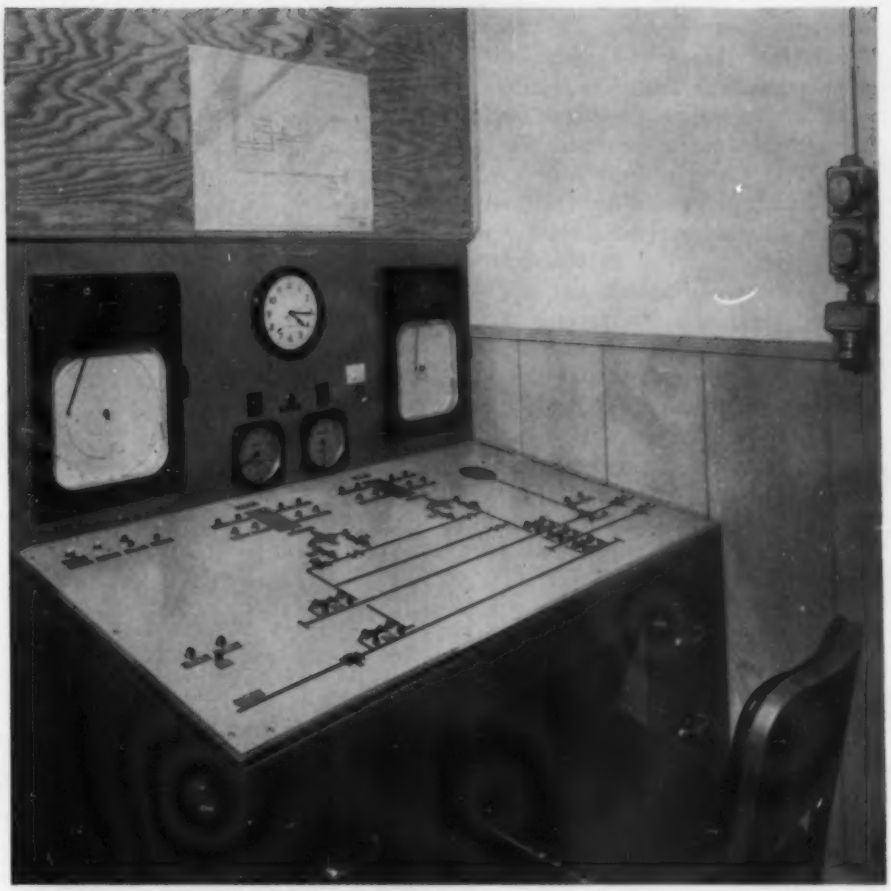
Ehrhart & Arthur, Inc., Los Angeles and Oakland, furnished engineer-

ing services for the design and constructed the new station.

Noise abatement. Typical of the expanding Los Angeles basin, industry had grown on one side of the station and a sizable residential development had been completed on the other.

Noise abatement and vibration attenuation from operation of the proposed gas engine drivers would be a strict design requirement. Investigation of building materials having a low factor of sound transmission through a wide range of frequencies indicated the mass of the material to be an important factor.

Accordingly, pump house construction consists of a steel frame structure with concrete block walls and a 4-inch thick concrete roof slab. These materials were also adaptable for construction of a building having a suitable architectural design. Wall mass was further increased by filling the wall blocks with concrete. The sound level of the engine exhausts was reduced by the horizontal installation of hospital zone type exhaust mufflers in a concrete trench at the rear of the station and extension of the stacks above the roof level.



Graphic-type control console at Stewart station is equipped with recorders for suction and discharge pressures at Norwalk station; a fluid level indicator for Norwalk storage tank; alarm signal lights; and the graphic panel containing pushbutton switches and corresponding signal lights controlling the Norwalk pump units and valve operation.

Mainline pumping units. The crude oils transported in this system have viscosities requiring negligible efficiency-head-capacity correction factors on centrifugal pump operation and the line design throughput, 30,000 to 50,000 barrels daily, further indicated centrifugals for the installation. Two centrifugal pumps were selected to meet the hydraulic characteristics of the pipe line. Use of variable speed drives enable the pumps to operate at peak operating efficiencies, and consequent minimum horsepower input requirements, throughout the range of the line's head-capacity curve. The pumps are manifolded with block valves on each suction and discharge with a check valve between these lines so each pump may be operated singly or in series. This utilizes either pump for minimum line operating throughput with the other pump as a standby or permits series operation of both pumps for maximum throughput.

The pumps are 4-inch, 2-stage units fitted with mechanical seals and sleeve bearings. Maximum operating speed is 3900 revolutions per minute.

Thirty pounds per square inch gage station suction pressure is maintained and maximum station discharge pressure is 600 psig.

Internal combustion engines were selected to obtain the advantages of variable speed drives—elimination of throttling losses and maintenance of peak pump efficiencies through a wide range of head-capacity conditions.

A study of the fuels available in the area showed fuel gas to have a decided economic advantage. Fuel gas also offers low engine maintenance costs. These advantages of gas engine operation were further improved by the installation of high-compression heads resulting in a lowered specific fuel consumption. Gas engines were specified as normally aspirated having a 300 bhp output with a 1200 fpm maximum piston speed and 60 BMEP engines, a 12-cylinder V-bank design with a 3711 cubic inch displacement, were selected.

Speed increaser gears convert the 1000 rpm maximum engine speed to the 3900 rpm maximum pump speed. A clutch installed between the engine and gear permits starting and idling of the engine without connection of the pump load.

Station operation and remote control. The new station is controlled from Union's Stewart pump station, an originating station 12 miles upstream from Norwalk. Telemetering is maintained on an existing physical between the two stations.

Stewart control consists of individual starting and stopping of the main line pumping units, valve switching, monitoring of station operating conditions and indication of station automatic shutdown devies.

After start-up, Norwalk is self-controlled to maintain a 30 psig station suction pressure and a 600 psig discharge pressure. A dual range pressure controller receives the suction pressure as a primary control requirement and the discharge pressure as

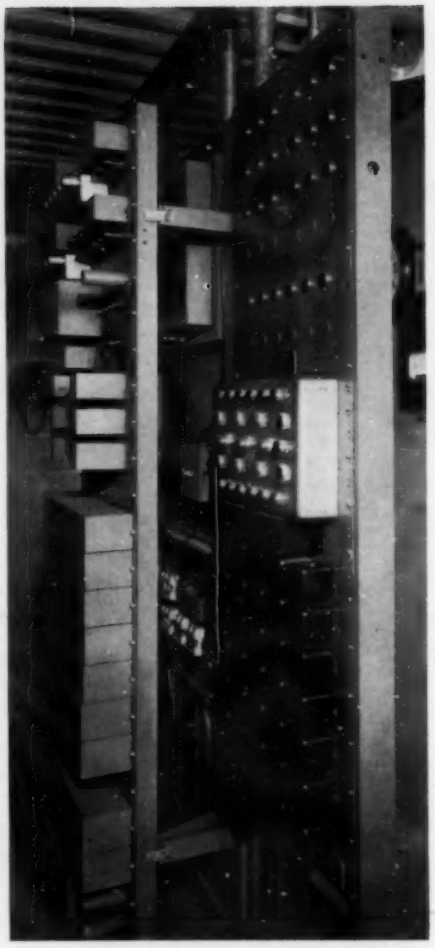
an over-riding function. The output signal from this proportional instrument controls a diaphragm motor valve in the station discharge line to counteract sudden pressure fluxuations. This signal is also received by a second pressure controller containing a wide proportional band and reset. The signal produced in this instrument is transmitted to the engine governors. Thus, the first derivative function regulates a control valve to absorb immediate pressure changes and the second derivative with wide band controls the engine speed with a minimum of hunting. Engine governor response is further retarded by installing a small balance tank between the final controller and the engine governor.

Stewart station is equipped with a graphic type control console for remote operation of Norwalk. The panel contains recorders for the station's suction and discharge pressure, a level indicator for the station's storage tank, alarm signal lights, and a graphic panel mounting push button-control switches for pump unit and valve operations with corresponding indicating lights.

Four push-buttons are required for the operation of each engine and a corresponding lamp is energized to indicate the active function. Control is individual to each pumping unit and is limited to: engine start, engine load, engine idle, and engine stop. Signals from these contracts are received into engine sequence control units located at Norwalk.

Assuming that Stewart station is operating at maximum discharge pressure, Norwalk station is shut down and by-passed, and dispatching requires an increased throughput; start-up of Norwalk boosting would be performed in the following sequence:

1. Engine start switch on one engine would be depressed. The engine controller receiving this signal performs two simultaneous functions: the pump house exhaust fans containing the gear lube oil coolers are started; and the motor operators on valves in the pump suction and discharge lines are energized to open these valves. The latter allows partial flow through the engine jacket water versus crude oil exchanger in the pump suction line.



Annunciator panel (upper right) indicated by red lights which function was involved in causing a shutdown. As soon as trouble is eliminated, operator uses the local control panel (immediately below annunciator panel) for starting engine and engaging clutch. To left of these panels is the supervisory control panel.

Open position limit switches on these valves close a circuit permitting the controller to perform the function of checking required minimum pressures from mercury switches installed on the engine starting air and fuel gas supply lines. Suitable pressures in these systems complete circuits enabling the controller to initiate the engine cranking cycles. Solenoid valves on starting air and fuel gas are opened and closed for five sequences, each position being maintained for approximately ten seconds.

Engine starting during any sequence is indicated by a vacuum switch on the engine intake manifold and subsequent sequences are bypassed. After starting, the engine comes to the idling speed maintained by the governor and circulates jacket water and lube oil.

Mercury switches on these two systems close circuits when operating lube oil pressure and jacket water temperature requirements are met. This is the final circuit closure on the engine start-up.

A signal is transmitted to Stewart and energizes the panel lamp indicating "engine idling." Failure of any circuit closures in these sequence energizes the panel lamp "engine failure."

2. Engine load switch operation is the next sequence in station start-up. In this circuit, a solenoid valve is opened on the airline to the clutch to engage the pump and gear unit and simultaneously, a solenoid valve is opened on the control air line to the engine governor.

This places the unit on the line and the engine speed is then controlled to maintain the station's suction pressure. Stewart panel lamp "engine loaded" is energized.

3. Engine idle switch operation performs the function of disengaging the clutch and isolating the engine governor from the control air line. The engine is maintained at idling speed and "engine idle" lamp is energized. This operation is used as a sequence in bringing the engine to stop or to maintain engine operation during short periods of taking a pump off the line.

4. Engine Stop results in blocking the fuel gas supply, and subsequent closing of the pump suction and discharge valves. Closed position limit switches on these valves energize a circuit indicating "engine stop" at Stewart.

Station safeguards. Mercury switch instruments have been employed to provide the station with safeguards. These switches are placed in circuits to either shut down the entire station or stop individual pumping units. Failure of functions is indicated at Stewart station by four indicating lamps: Station Failure, Engine Failure (2), or Fog System Operation. An annunciator panel is provided at Norwalk, however, to indicate the specific function causing the shut down.

Station safeguards include:

Fog System Operation
Low Fuel Gas Pressure

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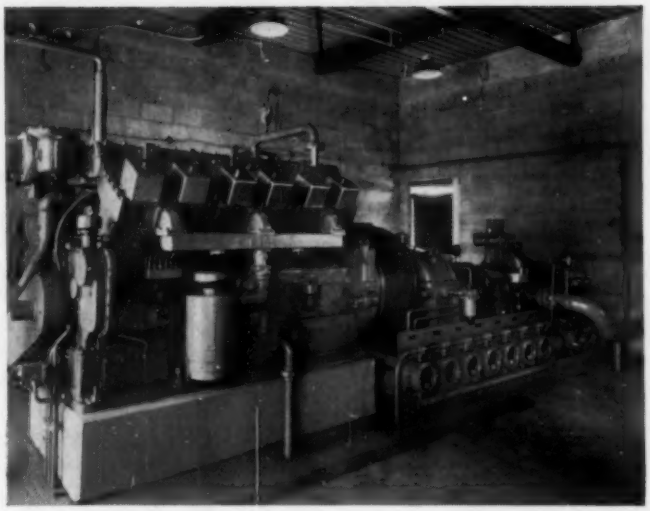
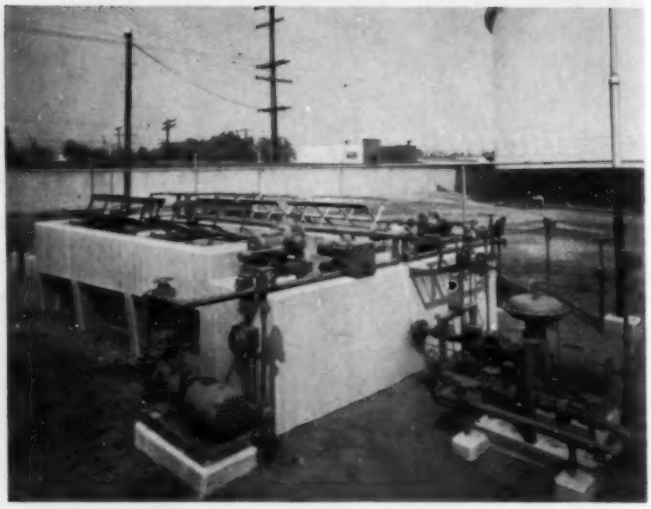


One of the two V-12 natural-gas-powered engines which drive a 4-inch, 2-stage centrifugal pump. Note row of mercury switches on panel beside pump at extreme right. Switches are part of the engine fail-safe circuit protecting equipment against failure of any engine or pump functions. Note dry-type fog system piping (above engine and pump) which is actuated by temperature sensing switches.



Water-oil mixtures that do not separate out in storage tank are pumped into this flotation unit for separation. Using a design prepared by Union's research department, the process involves acceleration of oil-water separation by means of microscopic bubbles which attach themselves to oil particles. Slowly-turning paddle wheels assist in removing oil from top of waste water. The space-saving, compact unit replaces extensive open-type sumps.

Low Station Suction Pressure
High Station Discharge Pressure
Low Instrument Air Pressure

Individual engine fail-safe devices include:

High Engine Jacket Water Temperature
Low Engine Lube Oil Pressure
Low Level Engine JW Tank
Low Clutch Air Pressure
High Gear Bearing Temperatures (4)
High Pump Bearing Temperatures (2)
High Pump Case Temperature
Pump Seal Failure

Station utilities. Jacket water for each engine is cooled in a shell and tube type cooler installed in the pump suction lines. Heat input to the oil stream reduces the viscosity and aids in pumping costs. Water temperature is maintained by a three-way self-contained temperature control valve that permits bypass of the cooler. Engine lube oil is cooled in a jacket water versus lube oil exchanger mounted on the engine.

Lube oil level is maintained from a gravity system with crankcase level controllers. Oil filters are installed on each engine system to provide bypass filtering. Air supply to maintain the starting, clutch and instrument air systems is obtained from an electric motor driven two-stage reciprocating compressor and is stored in two receivers.

Gear lube oil cooling is performed by wall mounted fan coolers that also serve as pump house exhauster. Oil temperature control is maintained by smaller models of the self-contained controller installed on the engine jacket water.

A dry-type fog system equips the pump room with fire protection. The control valve in this system is actuated by temperature sensing switches with electrical power maintained by storage batteries equipped with trickle chargers.

Waste water disposal. An additional station operating requirement is the receipt and disposal of waste water. This water, produced in Union's Sansinena field, is received as a shipment from Stewart station into a 80,000-barrel floating roof tank adjacent to the pump station. A 10-percent water-cut indicating switch and a three-way valve are installed in the Norwalk receiving line to facilitate the remote control of switching this shipment into the tankage. Gravity separation in the tank allows a major portion of the crude oil to be recovered through a swing line and pumped into the station suction header.

The remaining oil and water is bled to a twin flotation unit for separation; recovered oil is pumped back to the storage tank and separated water is pumped to a water storage tank for release in a waste water disposal line.

Process design of the flotation unit was prepared by Union's research department. Briefly, the dissolved air flotation process involves the acceleration of oil and water separation by means of microscopic bubbles which attach themselves to the oil particles. These bubbles are obtained by recycling a portion of the effluent water under pressure to the active flotation cells.

Pressurized air is injected into the recycle stream where a portion is dissolved and the remainder dispersed throughout the stream. Upon re-entering the flotation cell, the pressure is decreased and dissolved air evolves as microscopic bubbles. In the process of formation, the bubbles attach themselves to foreign particles in the water and accelerate the rise of these particles to the surface.

Severe corrosion is experienced in the recycle and effluent water lines. Transite baffles were used for cell separators and weirs, plastic piping was required, and recycle and effluent pumps are constructed from corrosion-resistant materials.

—**The End**

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Engine-Driven Centrifugal Compressor Being Fitted for Automatic Operation

Three veterans of pipe line service have been unitized for automatic control. A gas engine, step-up gear assembly, and centrifugal compressor will be adapted to this new application.

By DAVID M. SALLS, The Cooper-Bessemer Corp., Mount Vernon, Ohio

One of the most interesting recent developments in the design of compressor units is the engine-driven centrifugal. This unit consists of three elements. Each has been used for many years in the pipe line industry, so perhaps it should be called development of an application. The prime mover is a high output, supercharged gas engine capable of a maximum delivery in the order of 4500 brake horsepower. A step-up gear raises the crankshaft speed to that required by the centrifugal compressor.

Larger volumes, above 5000 cubic feet per minute, generally can be handled with single-step increasers. The centrifugal compressor is a standard unit.

One of these engine-driven centrifugal compressor units is being built for a major natural gas transmission line. The unit will go into service this fall. The engine is a V-16 supercharged gas engine rated at 3700 BHP at 327 revolutions per minute. Its maximum speed is 360 RPM which is 10 percent over normal speed. At maximum speed, the compressor load can be as high as 4500 BHP. Fuel consumption at full load is 6200 BTU/BHP per hour.

Engine intake air is compressed in the turbocharger; cooled by a water-cooled intercooler, and further cooled by a turbo-expander compressor unit. Air supplied to the power cylinders is at about 100° F., depending upon ambient conditions. Since the air is not cooled by evaporation, make-up water is negligible.

This unit requires a two-step speed increaser drive as the compressor is rated at 5500 RPM normal speed. The compressor is a pipe line centrifugal compressor; a single-stage unit with overhung impeller and 24-inch ASA 600-pound suction and discharge flanges. Flanges are on a common centerline at right angles to the axis of the shaft. A coverplate on the front side of the compressor can be removed for access to the impeller and the entire rotating assembly. The outboard main bearing and the thrust bearing also can be removed from the drive end as well.

Unit coupling consists of a low-speed shaft assembly and high-speed coupling. Coupling sizes and shaft lengths have been investigated carefully for torsional vibration characteristics.

The over-all length of the unit from the turbocharger air inlet flange to coverplate on the front of the centrifugal compressor is 46 feet and 2 inches. Pitch spacing of units placed side by side would be 22 feet. Estimated total weight of the unit including engine, gear, and compressor is 337,000 pounds.

SUPERVISORY CONTROL OF CENTRIFUGALS

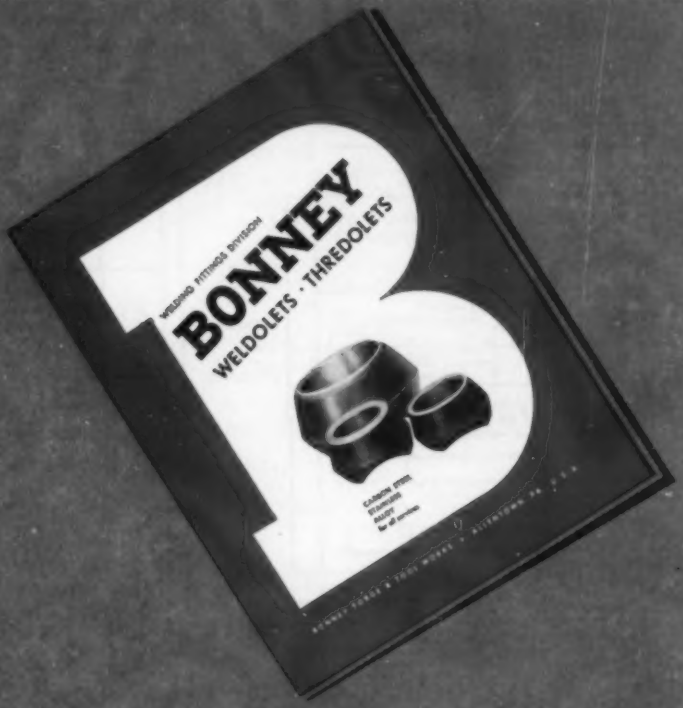
An engine-driven centrifugal compressor unit is well suited to operation under a supervisory control system. The operator needs only to push a master control switch on a panel board to start the engine and put it on the line automatically. Engine speed can be adjusted manually or an oil relay governor with a pneumatic head can be used to automatically adjust the engine speed to maintain a set discharge pressure. The next step in automatic operation would be to operate the automatic starting control switch from a distant point such as another compressor station or the company dispatcher's office. Such a system should have telemetering equipment so that the person operating the compressor unit will have indications of the engine speeds and line pressures. Alarm signals should also be transmitted to the remote point of operation so that the operator will know of any malfunction at the station.

A circuit diagram for performing the above supervisory station control of the unit is shown in Figure 1. This well-engineered system offers possibilities of substantial savings in station operating costs. It is similar to an installation that has been in operation for several months on a reciprocating compressor unit in Northern Natural Gas Company's station at Mullinville, Kansas.

A SUGGESTED SYSTEM FOR AUTOMATIC CONTROL OF ENGINE-DRIVEN CENTRIFUGALS

The control system largely employs electrical devices as a means of providing fully automatic control of the centrifugal compressor unit. "Off" engine unit controls can be located on a panel beside the individual engine or can be grouped on panels in a separate control room as desired, depending on the specific station layout. The panel shown in Figure 1 is for a station with a common water-cooling system for all units, but individual unit motor-driven jacket water pumps.

The design requires a number of operating personnel and provides both visual and audible anticipatory alarms to show conditions departing from



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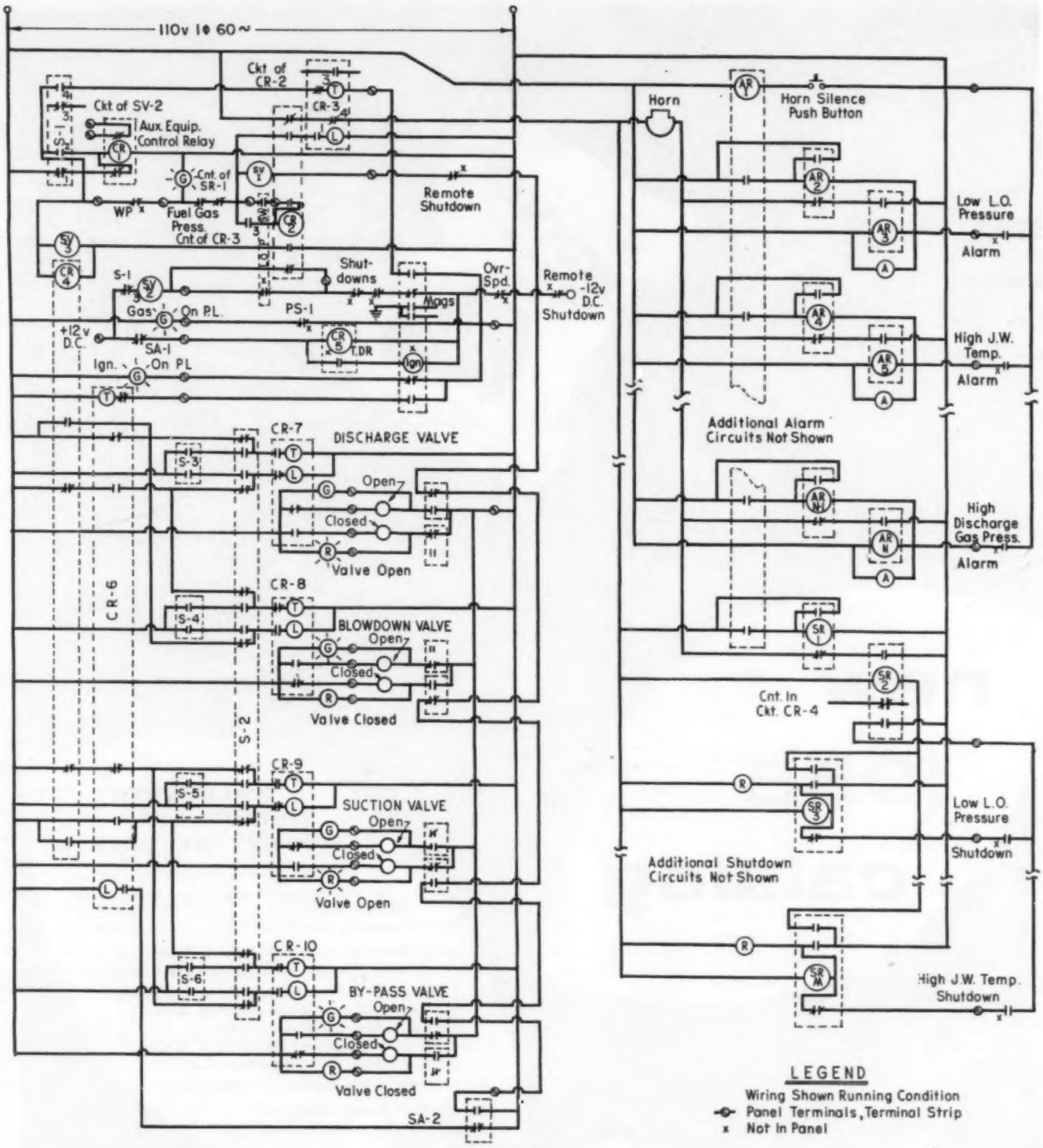

FIGURE 1
(See operation next page)

normal on services such as lubricating oil and water temperatures and pressures. With the development of satisfactory automatic valve operators for local and remote control, it is possible to start and place a centrifugal unit on a line with one operator.

The control system permits an operator to start a centrifugal compressor unit and place it on the line with the minimum of manual operations and the maximum of safeguards. The only manual operations required are (1) operation of master control switch and (2) adjustment of the speed. This panel provides adequate indicator lights to determine the position of the valves and tachometer for engine speed. All electrical equipment is explosion-proof.

This control system for an individual unit is affected by the general station layout. Fewer controls are involved if the self-contained unitized compressor engine setup is adopted. The control circuit shown was developed for 110 volt, 60 cycle control voltage, however, other voltages may be used. Parts used in the circuits are standard manufactured items. Some auxiliary power is required around any station, so the provision of a 12 volt direct current control system with charger probably represents the most simple and dependable standby control arrangement.

ACKNOWLEDGMENT

This article taken from a paper presented at the American Gas Association, Gas Supply, Transmission and Storage Conference, Pittsburgh, Penn., May 9-10, 1955.

Preparation for Start-Up

1. Check for power to panel.
   a. Discharge valve—green light "on" indicating "valve closed"
   b. Suction valve—green light "on" indicating "valve closed"
   c. By-pass valve—red light "on" indicating "valve open"
   d. Blowdown valve—red light "on" indicating "valve open"
2. Check for fuel gas pressure.
3. Check to insure that:
   a. Valve control is set on "automatic"
   b. Alarm circuit switch is set in "on" position

START

PANEL OPERATION	EQUIPMENT OPERATION
A. MANUAL OPERATION:	
1. Manually turn "master unit control" switch to "start" position and release to "run" position	
B. THE RESULTING OPERATIONS ARE ALL AUTOMATIC	
1. Auxiliary control relay CR-1 closes (Green light for "Aux" comes on.) "Holding relay" CR-2 energized.	Water pump starts closing water pressure switch W.P.
2. "Valve control relay" CR-4 energized by "Holding relay" CR-2, energizing, "open circuit" of discharge valve; (Red light comes on indicating discharge valve "open" and green light goes out), "close circuit" of blowdown valve; (green light comes on, red light goes out.) Starting "speed" control solenoid SV-3 energized.	Discharge valve opens. Blowdown valve closes.
3. After valves complete travel interlock circuit of starting air solenoid SV-1 completed.	Starting air valve opens and engine rolls, purging air and exhaust systems, building up scavenging air pressure.
4. Scavenging air pressure switch SA-1 closes, energizes purging time delay relay, CR-5. After 10-15 seconds time, purging delay relay CR-5 closes, energizing the ignition relay "Ign." (Green light indicating "ignition on" is lit).	Following purge period, ignition is turned on.
5. Ignition relay "Ign" energizes gas solenoid SV-2 (Green light indicating "gas on" is lit)	Gas admitted to engine in starting quantity, by automatic gas control valve. Engine starts and accelerates to low speed, coming under governor control. Scavenging air pressure and lube oil pressure increases.
6. Scavenging air pressure switch SA-2 is actuated, de-energizing starting air control circuit through solenoid interlock circuit, SA-2 also operates "valve control relay" CR-6. Relay CF-6 sets up circuits for opening suction valve and closing by-pass valve.	Starting air is shut off.
7. Lube oil pressure switch operated by oil pressure, opens circuit to relay CR-2.	Engine pump has developed normal lube oil pressure, and lube oil shutdown OPS is in normal running position.
8. Release of CR-2 permits governor to take control of engine, brings safety shut downs into circuit, and drops valve control relay CR-4. The running speed is set by means of the speed control knob located on the panel. If the speed at the time the engine was shut down was engine rated speed, then the engine at this time accelerates to rated speed, providing no adjustments have been made with the speed control knob. As an alternate to this manual control of speed, automatic speed and/or unloading controls can be provided if desired.	Engine accelerates to previous running speed setting. Suction valve opens and by-pass valve closes. Engine is now on the line and loaded.
9. Release of CR-4 completes, open circuit of suction valve (red light "on", green light "out"); close circuit of by-pass valve (green light "on", red light "out").	Suction valve opens, by-pass valve closes.
10. Engine on line pumping gas.	

Relay CR-3 is a "cutout" to de-energize the shutdown circuits when unit is stopped. This relay holds the shutdowns out for starting, allows shutdowns to "come in" after engine is running.

STOP

Turn "master control unit" switch to "stop". Engine will immediately shut down in the following manner:

1. "Gas solenoid" SV-2 immediately closes shutting off the gas.
2. The ignition is maintained while the engine is still turning from momentum.
3. As the scavenging air pressure falls, scavenging air pressure switch SA-2 operates, causing the discharge and suction valves to "close", by-pass and blowdown to "open" through circuits of "valve control relays" CR-4 and CR-6.
4. Further decrease in scavenging air pressure results in releasing ignition relay "Ign".
5. The engine is now down and all relays and their contacts, including lights, are in the position described prior to starting.

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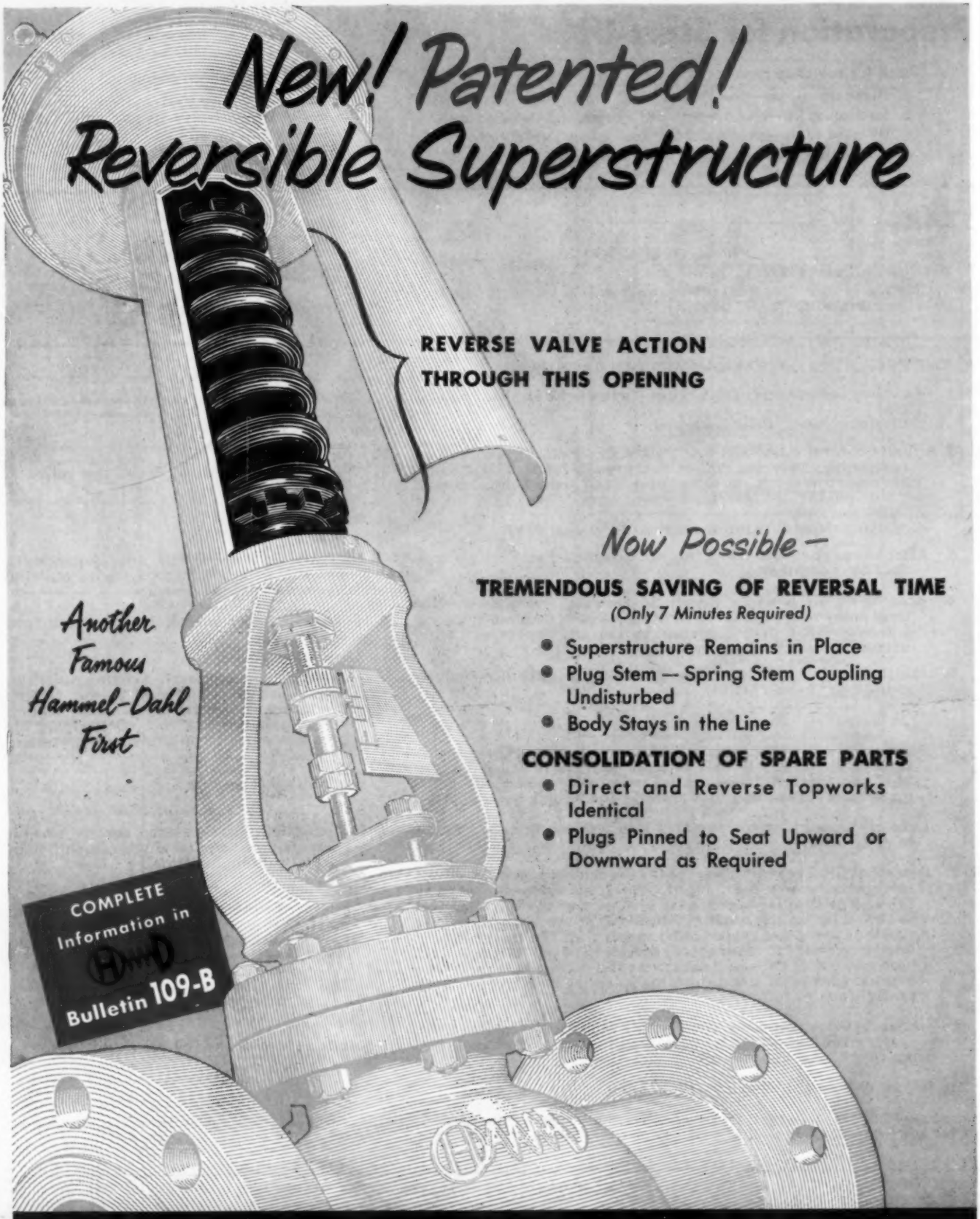

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CANADIAN MANUFACTURING AFFILIATE—GUELPH ENGINEERING CO., GUELPH, ONT.

1 Crews, with the aid of four side-boom tractors, assemble pipe line bundle on launching dollies preparatory to strapping and installation of pontoons.

More pictures on next page . . .

Multi-Lines Laid Together as a Bundle

Four pipe lines and a telephone cable successfully installed offshore at a savings in cost by banding them together with metal straps.

By **GILBERT M. WILSON,** Pipe Line Industry Staff

Four pipe lines, plus a multiple conductor submarine telephone cable, all banded together with heavy metal straps to make a single circular-shaped bundle, recently were successfully pulled and laid across 8300 feet of water. Although some unusual problems were encountered, the techniques employed may point the way to future multiple-line submarine operations.

The difficulties were outweighed by saving in costs and the advantage of having to provide only one trench and a much narrower one than if the lines had been laid horizontally side by side.

The lines connect the Monterey Oil Company-The Texas Company drilling island, off Seal Beach in Southern California, with shore facilities. One line, an 8-inch, is to be used to transport crude and natural gas ashore from producing wells. Three 3-inch lines will be used for fuel, water and drilling mud delivery, plus special well test purposes.

The pipe lines, strung out on the beach in 750-foot lengths, were pulled out and submerged using the controlled buoyancy technique developed by Collins Construction Company of Port Lavaca, Texas.

The 8-inch line was 28.5-pound, ⅜-inch wall line pipe, and the 3-inch were of standard line pipe. The telephone cable weighed 2.83 pounds per

Text continued on Page 61.
More pictures next page

2 Welders attach 1-inch thick, 18-inch diameter ring to nose end of the multiple line pipe line bundle preparatory to making the first pull. Thick steel caps, welded in place, close ends of the pipe.

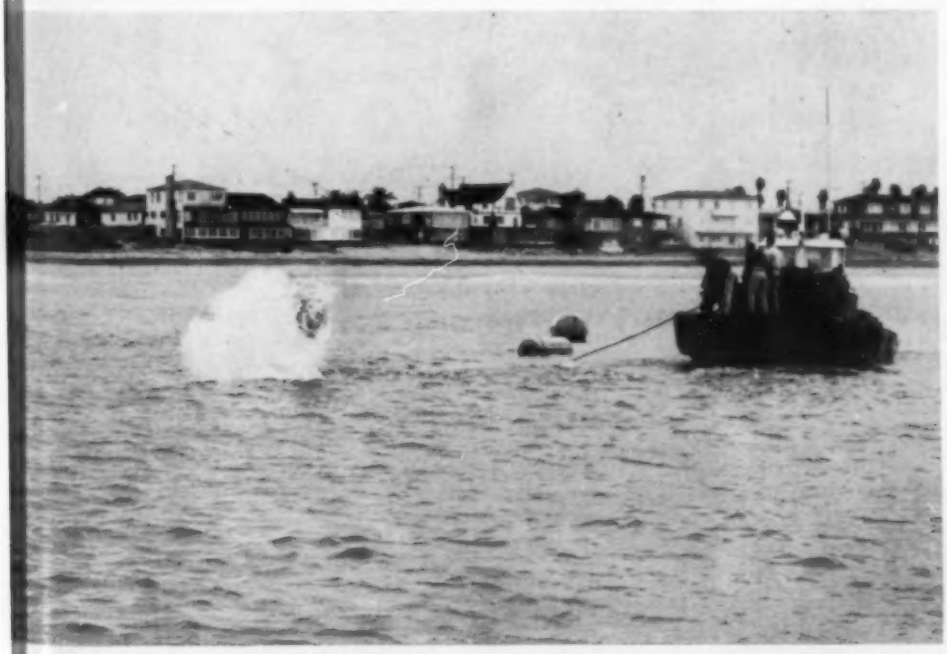
3 Dished and flanged half-inch steel head, with 3-inch thick pulling eye attached, is installed over the 18-inch ring that has been welded to the nose end of the pipe line bundle.

4 The four pipe lines and telephone cable were strapped at 10-foot intervals with high tensile steel 2-inch by .050-inch straps drawn up tightly by means of a ratchet binder (see photo at left). Asphalt-impregnated pads were placed between bands and mastic coated pipe to prevent possible damage to coating.

5 Controlled buoyance placed just before pull starts. When pipe is in position on ocean bottom, trip line (at man's feet) is pulled, releasing small float tank which in turn carries the pontoon release line to the surface. Pulling upward on the release line shears steel bands, allowing pontoon to come to surface where it is retrieved by work boat.

7 This photograph taken beneath pipe line cluster shows how the three 3-inch lines ride the dollies. Arrow indicates ends of fiber pads projecting down from between individual lines, protecting mastic coating.

6 Another 750-foot section slides into water despite a heavy sea. Self equalizing launching dollies near surf line automatically adjust to changes in tide. Drilling island and pulling barge are visible on the horizon.



8 With a sudden eruption of water and spray, another pontoon hits the surface to be retrieved and towed back to shore. Crew on workboat is moving along pipe line pulling up on each of the float lines to shear the steel bands holding pontoons to pipe line.

9 Submarine trencher working in shallow water. Machine is providing a 2½-foot cover for the pipe line on which it is riding. A second pass will be made over the entire length to provide the necessary cover of at least three feet in water out to the 15-foot depth contour and five feet of cover from there on out to island. Note outline of 10-foot wide trench at edge of the foam, caused by the surf and action of trencher.

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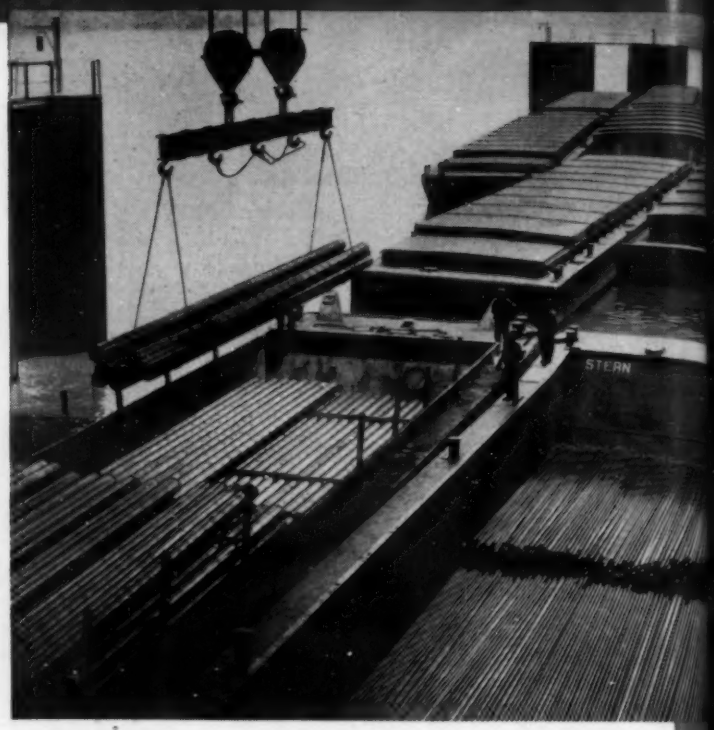

Loading line pipe at J&L's Aliquippa, Pa., barge docks

J&L's stocking and rail loading facilities at Aliquippa, Pa.

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J&L's stocking and rail loading facilities at Aliquippa, Pa.

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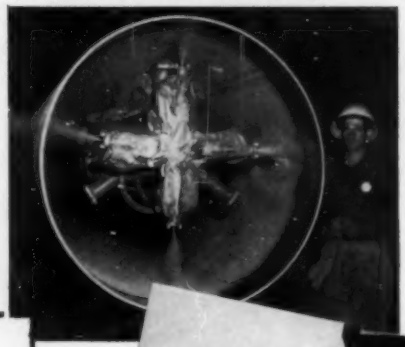
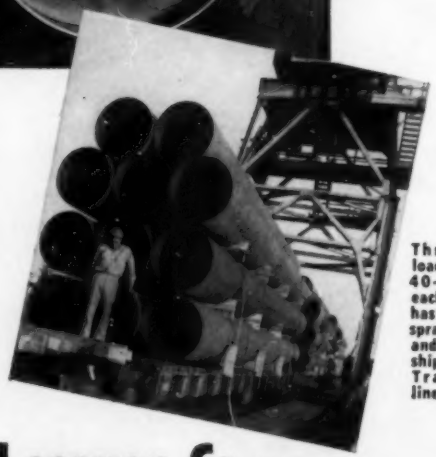
Rows of 36" pipe, destined for Transco's "Super Inch" line, as it is rolled from Consolidated Western Steel Company's Orange plant to Rossen-Richards' yard where it will be chemically cleaned and sprayed internally with Copon, the effective corrosion control coating.



Close-up showing how pipe is pressure-sprayed with Copon at Rossen-Richards yard in Orange, Texas. Pipe is rotated as automatic sprayheads are slowly pulled through entire 40-foot length of pipe.



Three flat cars loaded with eleven 40-foot joints each. This pipe has been Copon-sprayed internally and is ready for shipment to the Transcontinental line.

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Side boom tractor, carrying bundled ends of four pipe lines and telephone cable, brings up the rear as another 750-foot section is pulled out to sea. Note that telephone cable (being pulled off spool out of range of camera on right) is carried and supported by roller that is raised and locked in that position by workman as soon as pipe clears the tires. Roller is dropped back to its retracted position when new tie-in is made for next pull.

foot. In air, the combined cluster of lines, bands, pontoons and trip cable rigging weighed 80.23 pounds per foot but, with the controlled buoyancy of pontoons spaced at 54-foot intervals along the line, the weight in salt water was only four pounds per foot; so light was the weight that divers could move it as it rested on the ocean floor.

The pipe, in 40-foot random lengths, was yard-coated with mastic; ⅝-inch thick on the 8-inch, and ½-inch on the 3-inch. It was brought to the launching site on the beach and there welded, the joints X-rayed and field joints mastic coated. Each of the 750-foot sections then was air tested to 100 pounds per square inch and hydrostatically tested to 1000 psi. The sections then were pigged and plugged with wooden plugs pending final tie-ing-in and pulling operations.

The bundle was made up with the 8-inch on top of the 3-inch lines and with the telephone cable strung in the shallow groove between the 3- and the 8-inch lines.

High tensile steel 2-inch by .050-inch straps, having a breaking strength of 20,000 pounds, were wrapped around the bundle at 10-foot intervals. Damage to the mastic coating at these points was prevented by first encircling the bundle with a 5-inch wide by ½-inch thick asphalt-impregnated pad before the straps were cinched down with a ratchet binder. At those points, also, the telephone cable was given added protection by encircling it with a separate piece of the same pad material. In addition, before banding, short lengths of the material were placed between the three-inch lines and another piece was placed between those lines and the 8-inch.

The pontoons, placed at carefully calculated intervals in order to obtain the desired buoyancy, were double-strapped to the cluster; a pair of wooden saddles being placed between the 8-inch and the pontoon to lend additional stability.

The pipe line was pulled with a double line, necessitating the mounting of a single buoyant block on the nose. This block, having a 36-inch pitch diameter, was attached to the pulling eye with a heavy clevis. Mounted in a horizontal position, the block was able to swing up and down through a vertical plane, thus allowing it to adapt itself to the angle of the pulling line. Pulling with a double line also meant that a smaller diameter line could be used, with consequent less weight, and less drag on bottom ahead of the pipe.

No obstructions were found along the right-of-way, the bottom being smooth and sandy. The right-of-way was walked by a diver before pulling was started. Maximum depth along the undersea route was 42 feet, and this was near the island. The first seven feet of the line, including the block and nose assembly, was provided with zero buoyancy; this being done by attaching two pontoons, one a vertically-mounted 36-inch diameter unit attached to the block; the other a horizontal cylinder strapped to the line immediately behind the nose.

Pulling was done by a winch mounted on the deck of a derrick barge anchored offshore. The barge was progressively moved ahead along the right-of-way as successive tie-ins were made. The nose of the pipe was not allowed to approach closer than 750 feet to the derrick barge.

With the exception of one 27½-hour shutdown period, when heavy rain squalls prevented welding and making of field connections, pulling operations proceeded smoothly. Average time per cycle (from launching of one string to launching of another)

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was approximately 6¼ hours. The longest time was 7¾ hours and the shortest time was 5¾ hours.

The pulling load, as measured by the dynamometer, during the pulling of the final section, ranged from 50,000 to 70,000 pounds, the variation here being caused by the action of the heavy Pacific Ocean swells. Maximum starting pull at any one time was 90,000 pounds and this was for only a short time when operations were resumed after the above mentioned 27½-hour shutdown.

Communications during the operations were carried on by radio between the barge and radio-equipped cars parked on the beach.

Pulling was stopped when the pipe line reached a point 10 feet beyond the mid-point of the island. The trip line then was pulled, releasing the pontoons, one by one, for all but the first (front) 400 feet of the line. On this remaining section, eight pontoons were allowed to remain attached to the line to facilitate final tieing-in operations at the island. Buoyancy created by these eight pontoons made it possible for the island end of the line to be picked up in a gentle, 400-foot long curve. Pre-fabricated, long-radius bends were used in bringing the line up the riprap slope surrounding the island and to the final tie-in on the island deck. After testing, underwater trenching operations were commenced.

Used with marked success on previous jobs in various parts of the world, the underwater trenching device developed by the Collins organization is essentially a sled-like framework which straddles the pipe as it rests on bottom. High pressure streams of water and air are pumped through a series of jet nozzles mounted at predetermined intervals and angles along the leading edge of the sled "runners," the latter, in effect being manifolds which, in turn, are connected by flexible hose to powerful pumps and compressors on the barge.

As the powerful jets carve out a trench on either side and below the pipe line, the line simultaneously is lowered into it. Rubber-covered rollers inside the framework permit the trencher to ride the pipe line, cutting the trench underneath as it moves along. A diver usually rides the de-

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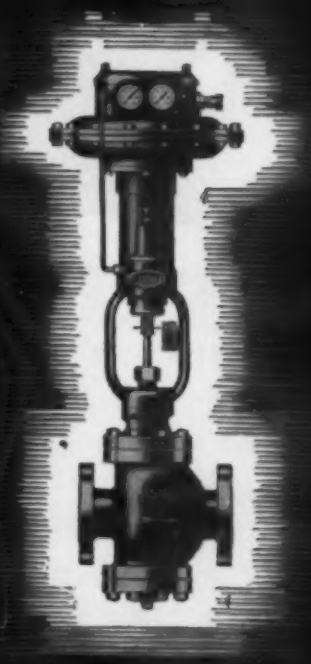

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vice, inspecting the trench and reporting his findings by telephone to the barge where changes in pressure or rate of progress is controlled. The trencher can travel in either direction, identical jets being mounted on either end and requiring only the turn of the hose manifold to divert the flow to the desired end of the machine. Controlled buoyancy pontoons, mounted on the sides provide vertical stability and weight control of the machine.

Lining up, welding, coating field connections and lifting the lines on to the launching dollies was more or less conventional, except that extra care had to be taken in the handling and placing of the small, more limber lines.

The trip line and pontoon release technique employed on this line was similar to that described in previous articles in PIPE LINE INDUSTRY. (See references at end of article). Atop each pontoon is coiled a rope, the length depending upon the depth of the water in which that particular section of the pipe will be laid. One end of this rope is attached to a rope sling which, in turn, is tied to the two handles of the cutter device, the latter shearing the steel straps that bind the pontoon to the pipe line. To the other end of the rope is attached a small buoy which has sufficient buoyancy to bring the rope end to the surface. The half-inch trip line extends the full length of the pipe line, being lightly lashed at regular intervals to the top of the pipe and up over the top of each pontoon, and securely attached to the small buoy.

Releasing the pontoons is a simple operation. Men in a small work boat move along the right-of-way, pulling up the lightly-secured trip line. This action releases the small floats which, in turn, bring the pontoon-releasing rope to the surface. A pull on the releasing line raises the cutter arms atop the pontoon, the steel bands are sheared and, with an upward rush of water and spray, the pontoon breaks the surface and shortly thereafter is picked up by a work boat and towed to shore.

U. S. Army Engineers required that the pipe line be buried to a depth

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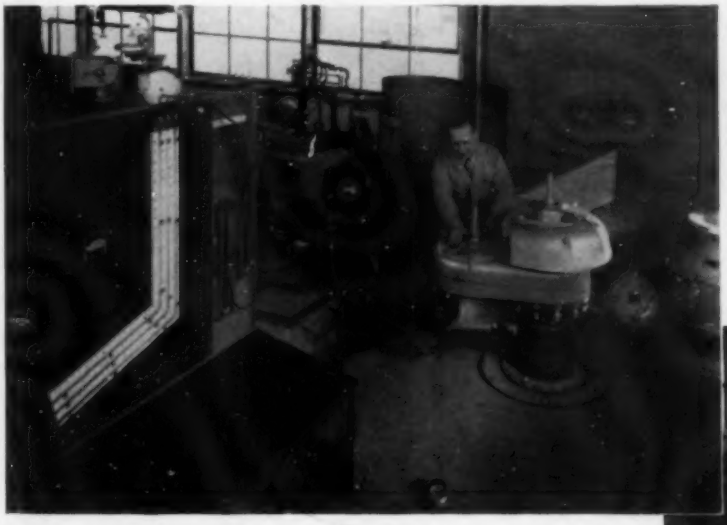
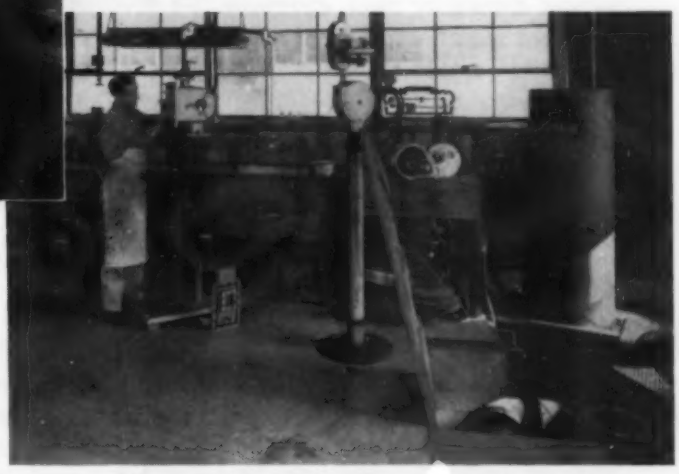
SHAND & JURS EQUIPMENT designed and manufactured for the petroleum, petro-chemical and chemical industries is thoroughly tested in S&J's own LABORATORY and proved in the FIELD under actual working conditions. The S&J engineering department has the most modern testing facilities available right in their own plant where every S&J design is exhaustively tested. Through cooperation with major oil company engineering departments, S&J equipment is also thoroughly field tested, before being placed on the market. This provides a double check that S&J equipment will perform as specified before it is put into production for supply to the industries S&J serves.

At the right is shown the Hydraulic Testing Section of the S&J laboratory. Here fluid handling equipment is tested for capacity to pass liquid and for head loss. The machine on the bench at the left of the picture is a high pressure hydraulic cycling device.



At the left is a section of the S&J laboratory with test tank and flow measuring apparatus for breathers, flame arrestors, vacuum and pressure relieving devices. The tank is built in strict conformity to API specifications.



At the right is shown the Automatic Tank Gaging section with a 25 foot gage-float testing well. Also included in the S&J laboratory is a chemistry section for corrosion studies and control, and for accelerated testing to simulate field conditions.

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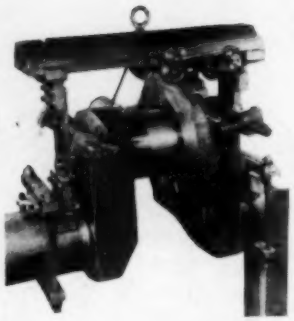
Saves Time and Money

Kinzbach Portable Boring Bar

Kinzbach Crank Pin Turning Machine



A skilled Kinzbach service crew will save you money by doing turning, boring and other operations on your engines and compressors without dismantling major assemblies. The Kinzbach Tool Co. has developed special equipment to handle many pipeline, process plant and refinery repairs and has had many years of experience in this type of work.

The Crank Pin Turning Machine may be mounted on the crank shaft within the engine, thus turning the crank pin without removing the shaft from the assembly. The machine will turn from 8″ to 12″ crank pins.

The Kinzbach Portable Boring Bar will handle bore diameters from 7″ to 32″ and lengths up to 48″. This machine bolts directly into the cylinder as illustrated.

If your maintenance job falls within these ranges, it's often less expensive to have these operations done by a Kinzbach crew right at your site, rather than dismantling and shipping the machine into the shop. Special adaptations of this equipment are regularly made to fit the needs of a wide variety of special and unusual jobs. Call or write the Kinzbach Tool Company for complete information about this money-saving service.

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sufficient to provide a minimum of three feet of cover between shore and the 15-foot depth contour line. From there on out, they required that the trench be deep enough to provide a minimum of 5 feet of cover. Since the bundle is approximately 2 feet in diameter, it meant, in the laying of this line, that the trench beyond the 15-foot depth line had to be 7 feet deep. Buried under this amount of cover, the line is secure against marine organisms, principally the pholas, a marine boring animal capable of boring through rock and other solid materials. In addition, the greater depth of cover assures protection against anchors, scouring of the sea bottom by currents, and other hazards.

All field welds, instead of the usual approximately 20 percent of them, were X-rayed to make doubly sure each joint was perfect. X-rays were made of the complete weld, also, not of only a segment. Although it is anticipated average pressures in the oil line will not be much over 100 psi, two hydraulic pressure tests, one before the pipe was launched and the other immediately after the pulling operation was completed, to a maximum pressure of 1000 psi.

All these precautions were designed by the company to prevent any possibility of water pollution or contamination.

Much credit goes to Monterey-Texas personnel in the designing of the installation; Healy-Tibbits Construction Company, San Francisco, general contractor of the project and who supplied the derrick barge and related marine equipment; Hood Construction Company, Lynwood, Calif., which handled all onshore work, welding, field joints and assistance in the pulling operations; and Collins Construction Company, which furnished all the submarine pipe line equipment, launching facilities, special submarine trenching and the technical supervision connected with the launching, pulling and trenching operations.

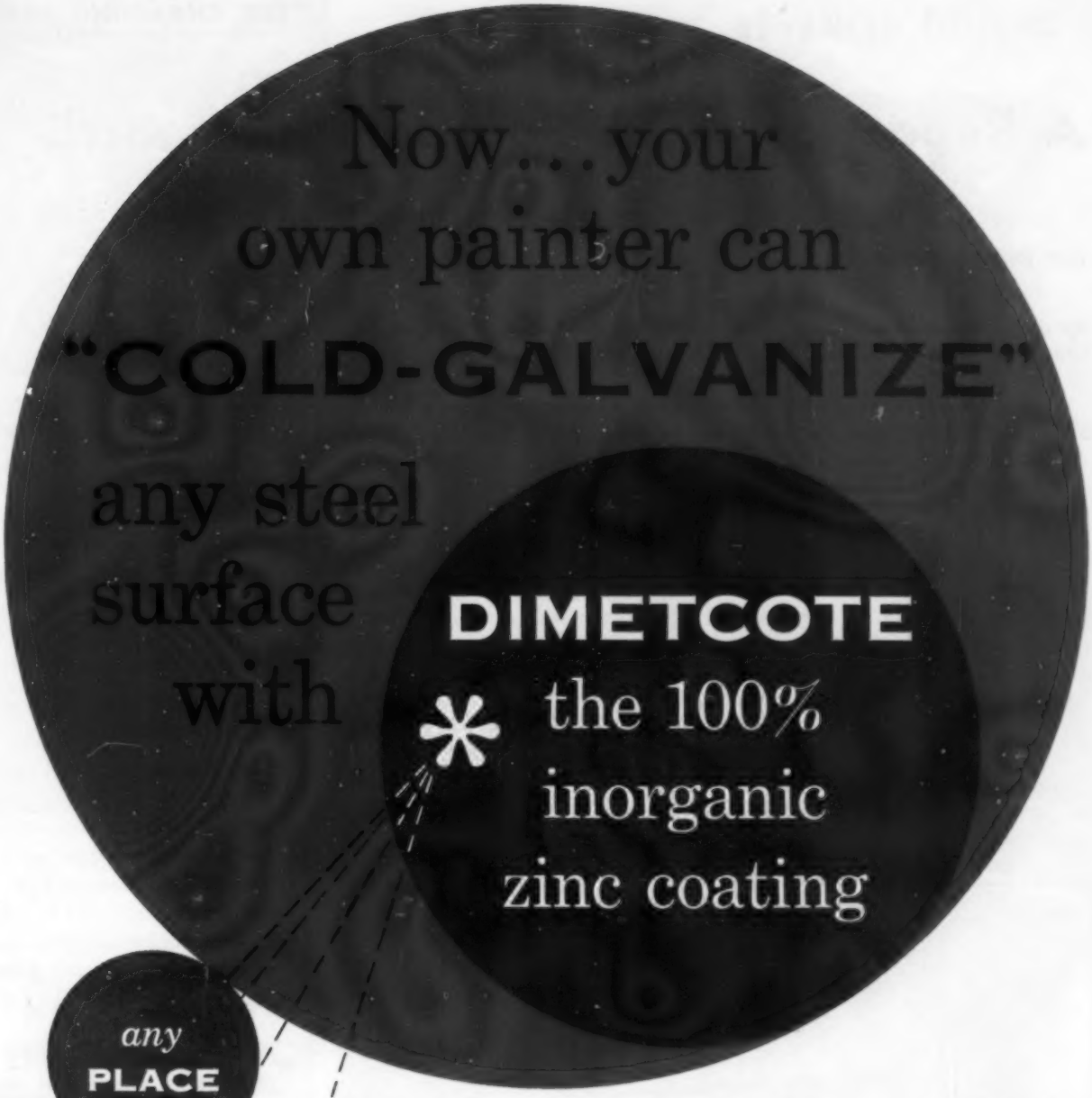
REFERENCES

World's Longest Sea-Loading Line. Donald M. Taylor. PIPE LINE INDUSTRY, July, 1954, Page 85.

Sarnia's Hamilton Harbor Crossing Is Designed to Settle 50 Feet. B. H. Mackenzie and P. T. Duff. PIPE LINE INDUSTRY, August, 1954, Page 80.

Pipeliners Fight 17-Foot Tides in Bay of Bombay. Donald M. Taylor. PIPE LINE INDUSTRY, February, 1955, Page 40.

—The End



Dimetcote is absolutely unique. It is not a paint, it contains no oils, resins or any other organic materials, yet it can be applied by spray or brush. When Dimetcote is applied to steel, a reaction takes place at the surface which produces chemical bonding as well as physical adhesion. It is almost impossible to find the interface between Dimetcote and the steel.

Dimetcote has many unusual characteristics. It shows no visible change after more than ten years exposure to the most severe weather conditions – sun, heat, fresh and salt water. It is insoluble in all solvents and petroleum products. It is highly abrasion resistant, but if abraded through to bare steel, the coating will cathodically inhibit corrosion.

Now tanks and structures can be given the same protection that galvanizing affords, *plus salt water resistance*. Existing structures need not be dismantled and new structures can be coated either before or after erection. *Only one coat* of Dimetcote over a sandblasted surface is required to protect such structures as:

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A Report on AGA-Sponsored Research

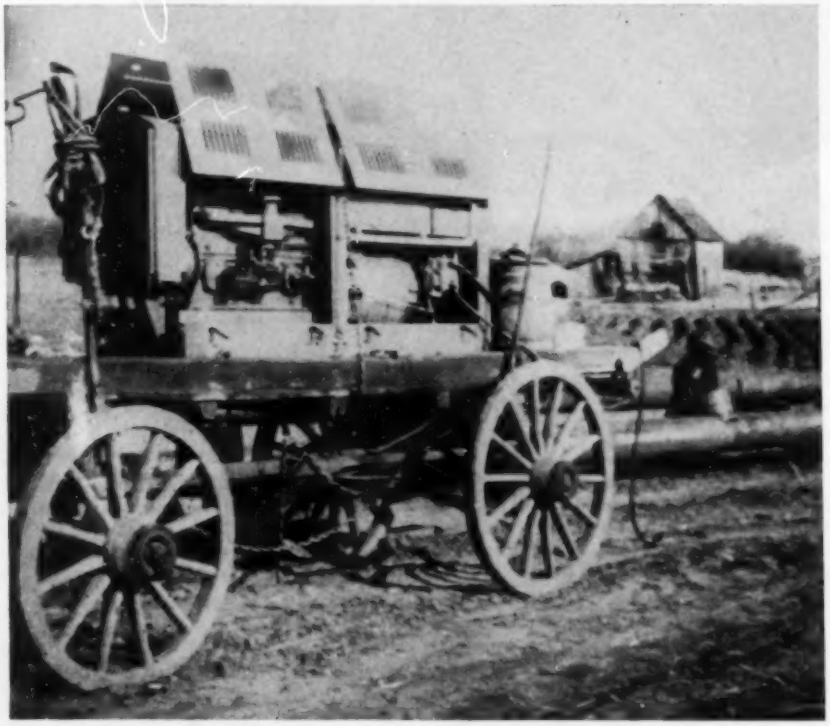
Emphasis for the most part was on transmission problems. Here is a list of the major projects.

By J. L. Thompson, Chairman American Gas Association Pipe Line Research Committee; Michigan-Wisconsin Pipe Line Company.

WHAT WAS accomplished last year and what is being done currently in American Gas Association sponsored research. For the most part, the major emphasis was on transmission problems. Here is a list of the major projects:

Large Diameter Orifice Meter Tube Tests, Project NX-4 (Cooperative)—Results of these tests were incorporated in Gas Measurement Committee Report No. 3 which has just been published. The report shows conclusively that equations for computing coefficients of discharge for orifice meters in AGA Gas Measurement Committee Report No. 2 may be used within tolerances given for meter tubes up to 30 inches in diameter.

Flow of Natural Gas Through Experimental Pipe Lines and Transmission Lines, Project NGD-5 (U. S. Bureau of Mines & I.G.T.)—Monograph available this summer. Transmission factors for turbulent flow of gas were determined for experimental lines of 2 to 8-inch seamless pipe, 8-inch welded pipe and 3-inch superfinished pipe. Reynolds numbers ranged from 49,900 to 36,000,000. Report is basic—not for design.



Good Old Days? The first electric welding units used on pipe lines started appearing around 1930, the year this picture was taken in southern Oklahoma. The unit was mounted on a wagon bed pulled by a team of horses. Today's welding units are self-propelled. This electric welder replaced oxyacetylene and made a weld 300 percent stronger.

Gas Measurement Committee Report No. 3, Project NX-7 (Cooperative)—Report which was published last month includes the following:

1. Data on larger diameter and heavier wall metering runs.

2. Specifications and tolerances regarding construction and installation of orifice meters.

3. A method of supercompressibility factor evaluation and basic tables.

4. Revised orifice factors for a base pressure of 14.73 and published expanded tables of supercompressibility factors within temperature ranges of 0 to 180 F; pressure, 0 to 3000 psig; specific gravity 0.554 to 0.750; carbon dioxide content 0 to 5 mol percent; and nitrogen content from 0 to 12 percent.

Girth Welding, Project NG-10 (Battelle Memorial Institute)—The studies have shown:

1. Base-metal cracking in the heat affected zones of girth weld joints increased rapidly as the carbon and manganese contents approached the maximum usually specified for Grade X-52 pipe.

2. Base-metal cracking increased with lowered welding temperatures.

3. Cracking decreased by preheat and immediate application of hot pass.

Continued work will be aimed at:

1. Producing crack-free joints in high chemistry API5LX pipe at low welding temperatures, using inert-gas-shielded process.

2. Evaluating weld-metal properties of inert-gas-shielded welds and

AVAILABLE IN 2 ADVANCED DESIGNS

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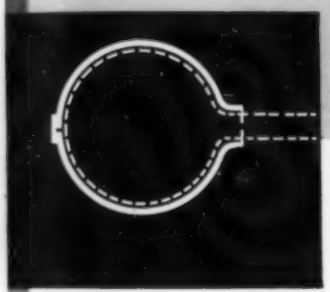
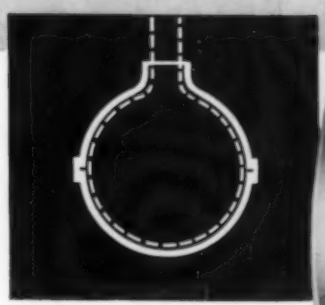
HOT TAP REINFORCING TEES





IMPROVE AND SIMPLIFY REINFORCEMENT OF HORIZONTAL OR VERTICAL BRANCH CONNECTIONS

L
TO MARK PROGRESS

For several years prominent pipe line companies have used this Ladish development as a practicable means to make safe hot-tap branch connections . . . and to reinforce the entire area of the connection with greater strength than otherwise possible.

Choice of design simplifies assembly . . . joints easily accessible for welding . . . welding heat safely away from direct contact with main line . . . minimum excavation required.

Reinforcing tees are available in sizes and wall thicknesses to meet your requirements.

Other Ladish Developments for the Pipe Line Industry include—*MULTIPLE OUTLET HEADERS, EXTRA LONG RADIUS (3-R) ELBOWS, ANCHOR FLANGES*

THE COMPLETE *Controlled Quality* FITTINGS LINE

LADISH CO.

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Security Oil

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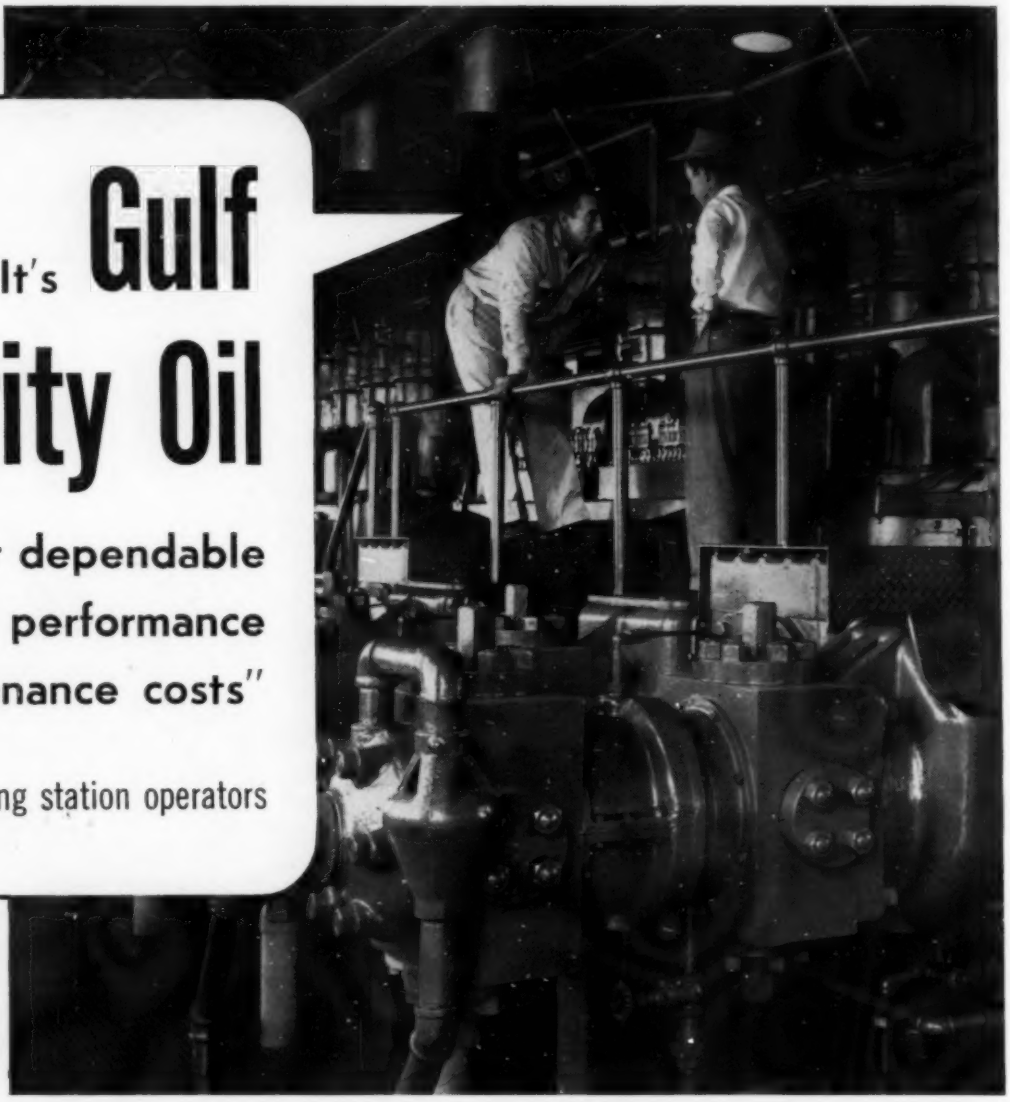
and low maintenance costs"

say pumping station operators



Smooth, continuous operation is a must for these units in service at a South Texas gas compressor plant. They are responsible for the steady flow of essential natural gas through pipe lines to homes and industries as far north as Detroit and New York. Gulf Security Oil provides the sure, effective protection needed for cylinders and bearings in both engines and compressors.

You can depend on Gulf Security Oil to provide the proper lubrication that is so important to vital compressor units if operating troubles are to be prevented and maintenance costs kept low.

Gulf Security Oil has a record of outstanding performance in scores of gas transmission plants. After years of operation with this quality oil, the cylinders and piston rings of both the compressors and power assemblies show negligible wear. And few carbon deposits have formed on power cylinder ports and pistons.

If you are installing new compressor units, or feel that you're not getting the most effective lubrication possible for your present units, it will certainly pay you to try Gulf Security Oil. Contact your nearest Gulf Office and have a Gulf Sales Engineer call.

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The finest petroleum products for your every need

comparing with welds made with covered electrodes.

Branch Connections Research, Project NG-11 (Battelle Memorial Institute)—This work concerns:

1. Additional investigation of field fabricated connections.

2. Investigation of basic fundamentals of hot tap fittings.

3. Determination of secondary stresses in pipe lines.

The results of research of unreinforced pipe line branch connections have been summarized by G. M. McClure and E. D. Abraham of Battelle in an article entitled, "How Stresses Affect Branch Connections," September 1954, PIPE LINE INDUSTRY.

Study of Particulates in Natural Gas Pipe Lines, Project NFX-12 (Arthur D. Little, Inc. and Cooperating Companies)—This work is expected to lead to suitable equipment and methods for determining suspensoids in high pressure gas lines. The results expected are:

1. Continuous monitoring methods and devices such as electronic photometer based on forward light scattering; instrument to record electrostatic charge given particles in gas stream; and monitoring devices based on discoloration of moving strip of filter paper.

2. Development or application of absolute methods: electrostatic precipitator for sampling; and absolute methods designed to give complete information.

3. Development or application of indicating methods such as vision tyndallometers, filters that show dust level by spot discoloration or low power optics to assay dust load of stream.

Pipe Line Efficiency Test Standards, Project NB-13 (Institute of Gas Technology)—Aimed at clarifying status of present practice and defining field procedures and calculation techniques for efficiency testing.

Interior Surface Coating of Pipe, Project NB-14 (Institute of Gas Technology)—This work will involve a critical survey of literature, field experience and other sources related to

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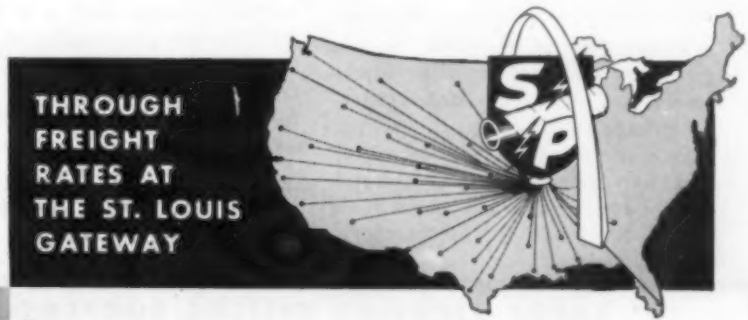
SPI is the only c/w company that steel grit cleans every piece of pipe, regardless of size, because steel grit cleaning produces the perfect surface to bond the coatings to the steel. Bond performance, over the years, is better.

If you want holidays for yourself, and not for your pipe, have it coated and wrapped at SPI under ideal conditions.



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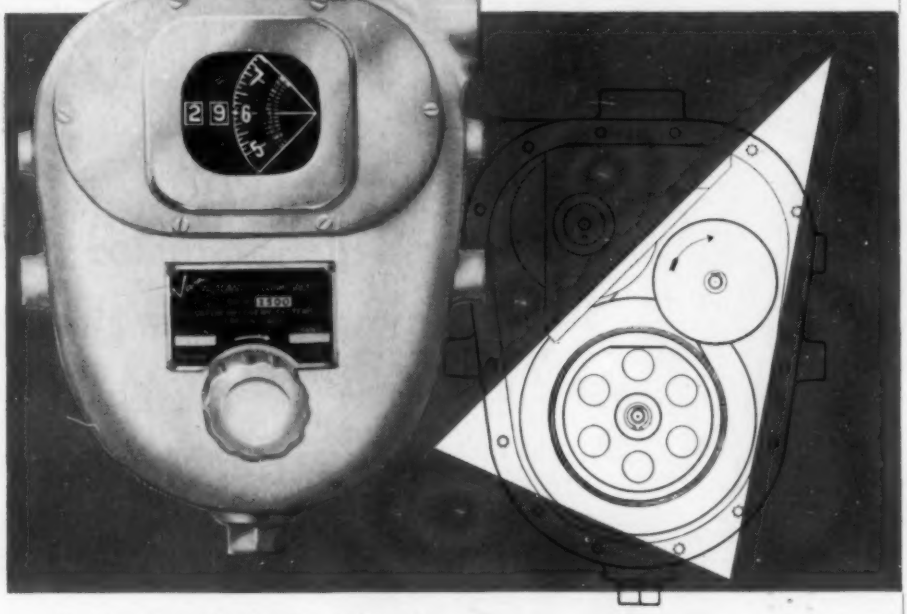
"Varec" FIG. NO. 2500 SERIES

AUTOMATIC TANK GAUGES

PIONEERED, DEVELOPED AND MANUFACTURED IN RESPONSE TO INDUSTRY DEMAND



Positive, convenient, mechanical counter reading combined with dependable accuracy—no smudgy, graduated tape to read through a cloudy glass.

The VAREC Figure No. 2500 Series Gauges have been developed, over a period of several years, in response to urgent field requests for a dependable automatic tank gauge which would eliminate difficulties universally encountered with tape reading, counterweight type gauges. The instrument now offered represents the results of sincere effort on the part of VAREC engineers, invaluable and deeply appreciated customer-cooperation, and experience gained from over 2000 installations covering practically every conceivable field operating condition.

Successfully incorporated in this gauge are such features as (1) liquid level indication on a mechanical counter arrangement for ease of reading, (2) operation checker, (3) gravity compensator, (4) simple calibration and gravity compensator adjustment from outside the gaugehead. Never necessary to gain access to tape, loosen support brackets or make adjustments in the presence of dangerous tank vapors, (5) provision for convenient addition, at any time, of auxiliary equipment such as mechanical limit or control switches, programmers, VAREC Remote Reading Gauger Transmitters, etc., (6) corrosion resistant materials of construction, as typified by the use of specially made Type 316 stainless steel ball bearings, and (7) all metal construction of components which insures electrical ground to tank shell.

The VAREC Figure No. 2500 Series Tank Gauges are now available for higher pressures (up to 300 P.S.I. working pressure) and, as is the case with the low pressure model, a combination of sound design, quality materials, and rugged construction is offered – not construction which meets only minimum requirements at a price.

Investigate before investing. Cheaper equipment is not always the least expensive equipment.

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961-B

internal coating for improved flow efficiency and maintenance requirements.

Orifice Metering of Pulsating Gas Flow, Project NQ-15 (Southwest Research Institute)—This new fundamental project has been initiated to solve these unanswered questions on this subject:

1. How much of accoustical theory is directly applicable?

2. What are the limitations of plane wave theory?

3. What are the factors of orifice plates, pipe bends, gage lines, etc.?

Line Pipe Research (Armour Research Foundation, Battelle Memorial Institute and Cooperating Companies)—The laboratory phase deals with notch toughness measurements of 213 heats of steel used for line pipe.

The field experiments included destructive tests of 30-inch pipe.

Phase Relations of Gas Condensate Fluids, Project NC-2 (U. S. Bureau of Mines)—Fundamental data pertains to phase relationships, correlations of phase diagrams and compressibility data and methods of testing gas condensate fluids.

Productivity of High Pressure Oil and Gas Wells, Project NC-3 (U. S. Bureau of Mines)—Aimed at measuring present well productivity and predicting future well productivity.

Deliverability of Gas from Underground Gas Storage Reservoirs, Project NC-8 (U. S. Bureau of Mines)—Studies existing methods and possible new methods of predicting deliverability of gas from wells producing from underground storage reservoirs.

ACKNOWLEDGMENT

This paper, "Pipe Line Research, A Key to Our Future," was presented at the American Gas Association Gas Supply, Transmission and Storage Conference in Pittsburgh, Penn., May 9-10, 1955.

Meeting May Speed Up Canadian Pipe Line

Canadian Prime Minister Louis St. Laurent has said that he hopes "real progress" will be made in an attempt to untangle the transcontinental natural gas distribution question when

Butyrate means pipe that is lightweight

Tenite Butyrate's light weight speeds installation. Three men can lay 4,000 feet of 4" Tenite pipe in a day. Eight men usually are needed to handle the same amount of metal pipe.

Butyrate means pipe that resists corrosion

You can bury Tenite Butyrate pipe and never worry about corrosion failures. Tenite resists corrosion by sour crudes, salt water and electrolytic soils.

Butyrate means pipe that resists paraffin clogging

You can prove to yourself that the smooth wall of Tenite Butyrate pipe offers no toe holds for paraffin. Install a test section like this in your present metal line.

What could Tenite Butyrate mean to you?

TENITE BUTYRATE PIPE means different things to different users. To a man troubled by corrosion, Tenite means pipe that resists the corrosive conditions found in oil fields. To a mah pumping high-paraffin crude, Tenite means relief from the frequent cleaning of paraffin-plugged lines. To a man laying a long string, Tenite means a lightweight pipe —easy to handle, simple to join. Tenite means other things, too... greater flow with less load on pumps, good impact resistance, flexibility to follow the contours of the earth, less year-'round maintenance.

Tenite Butyrate can promise long, trouble-free service for your crude, brine and water disposal lines. Get the facts on Tenite. Learn how, in field after field, Tenite pipe has proved its practical value. Mail the coupon for more information and a list of Tenite pipe suppliers. EASTMAN CHEMICAL PRODUCTS, INC., Kingsport, Tennessee, subsidiary of Eastman Kodak Company.

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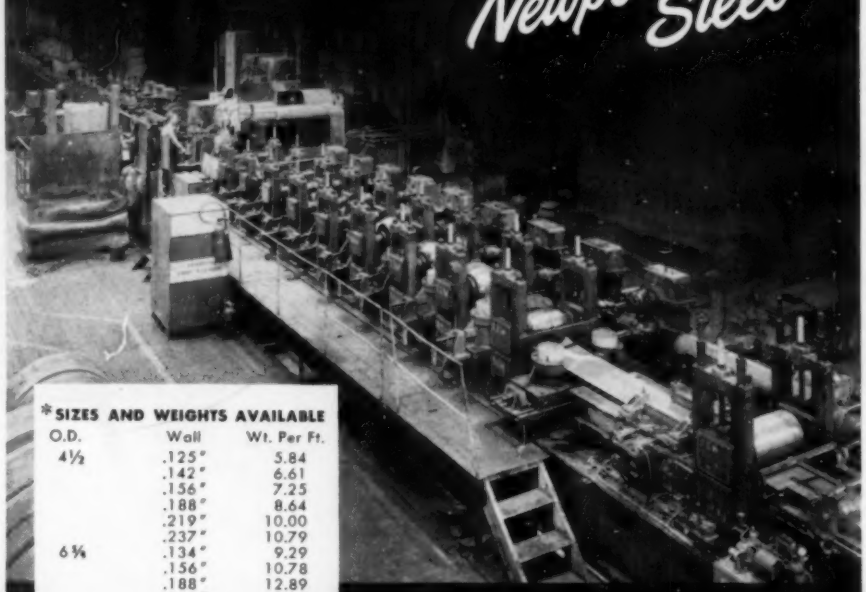
QUALITY STEEL MAKES
BETTER LINE PIPE* AT
Newport Steel



*SIZES AND WEIGHTS AVAILABLE

O.D.	Wall	Wt. Per Ft.
4½	.125"	5.84
	.142"	6.61
	.156"	7.25
	.188"	8.64
	.219"	10.00
	.237"	10.79
6⅝	.134"	9.29
	.156"	10.78
	.188"	12.89
	.219"	14.97
	.250"	17.02
	.280"	18.97

From steelmaking furnace to final fabrication, Newport Steel technicians systematically control each process and closely supervise each order to meet exact specifications. The resulting high quality and precision of operations combine with Newport's strategic location to provide line pipe users with an economical dependable source for 4" and 6" sizes.* Available in standard wall, or thin wall for maximum economy. Both meet API and ASTM specifications in every respect.

ECONOMICAL WATERAIL-TRUCK DELIVERY

Newport Steel is ideally situated on the Mississippi-Ohio River system and the great Cincinnati rail-truck hub. New barge facilities, 7 major railroads, 143 motor carriers enable Newport to give economical, dependable delivery to the entire area of the Middle West and South.

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Cold-Rolled Sheets
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Galvanized Sheets
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Colorbond Sheets
Electrical Sheets
Alloy Sheets and Plates
Electric Weld Line Pipe
Roofing and Siding
Eave Trough and Conductor Pipe
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YOUR CONFIDENCE IS JUSTIFIED WHERE THIS FLAG FLIES

A SUBSIDIARY OF MERRITT-CHAPMAN & SCOTT CORPORATION

Alberta and Ontario (Provincial) officials and gas company representatives meet in Ottawa soon. St. Laurent will attend as representative of the government.

When Canadian parliament opposition queried the Prime Minister as to the financing of the $350 million pipe line to extend from Edmonton to Montreal and whether the forthcoming meeting would "once and for all" settle the problem, St. Laurent replied that he did not know.

He told of having agreed last month to a request by Premier Manning, of Alberta, that he (St. Laurent) attend the meeting. "I told him I was sure we would all try to do something that would mean real progress" and he added that he understood the purpose of the meeting, convened by Manning, was one to assess the situation and to see what could be done to speed the delivery of western gas to Ontario and Quebec.

NPC Booklet Warns of Communist Threat

Some 1700 U. S. Communists have been assigned to the petroleum, chemical and rubber industries as part of an over-all plan to disrupt critical industries in event of war, according to a booklet prepared by oil industry leaders under the sponsorship of the national Petroleum Council.

The booklet claims that Communist plans call for a three-pronged attack:

- Labor disturbances
- Paralysis of transportation
- Destruction of critical industries

"The Communists know how to do these things," the booklet notes, "and management can deprive them of the opportunity."

The booklet, entitled "Disaster Planning for the Oil and Gas Industries." is intended to help individual companies map programs to meet such a threat.

Also released is a study on "Security Principles for the Petroleum and Gas Industries." This booklet recommends that companies develop an executive line of succession so that officials killed or incapacitated can be replaced.

The booklet also suggests that companies consider establishment of alternate company headquarters far from critical target areas.

Rules of Thumb

FOR THE PIPELINER'S NOTEBOOK

Miscellaneous

—21—Determination of leakage from gas pipe line using the pressure drop method.

To determine the leakage in Mmcf per year at a base pressure of 14.4 psia and a temperature of 60° F, take as a basis a one mile section of line under one hour test. Use the formula:

$$Ly = 9 \times D^2 \left[\frac{P_1}{460 + t_1} - \frac{P_2}{460 + t_2}\right]$$

where:

D is the inside diameter of the pipe in inches.

P_1 and t_1 are the pressure and temperature at the beginning of the test in psia and °F respectively.

and

P_2 and t_2 are the pressure and temperature at end of the test.

The error in using this formula is about 4 percent.

Example: A section of a 10-inch pipe line one mile in length is tested using the pressure drop method. I.D. is equal to 10.136 inches. Pressure and temperature at the start of the test were 190.5 psig and 52° F. After one hour the readings were 190.0 psig and 52° F. Calculate the leakage in Mmcf/year.

$$Ly = 9\ (10.136)^2 \left[\frac{204.9}{460 + 52} - \frac{204.4}{460 + 52}\right]$$

$$= \frac{(9)\ (102.7)\ (0.5)}{512}$$

$$= 0.903 \text{ Mmcf per mile per year.}$$

Corrosion Protection

—12—How to determine the efficiency of a cathodic protection rectifier.

Multiply DC voltage output times DC amperes times 100 and divide by the AC watts input. The answer is percent efficiency.

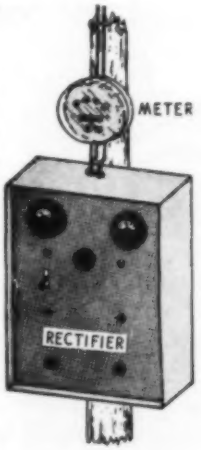
Example: A rectifier has an output of 50 amperes DC at 15 volts. The wattmeter gives a direct reading of an AC input of 1155 watts.

$$\text{Efficiency} = \frac{(\text{DC volts})\ (\text{DC amperes})\ (100)}{(\text{AC watts input})}$$

$$= \frac{(15)\ (50)\ (100)}{1155} = 65 \text{ percent.}$$

On those rectifier units that do not have a wattmeter, the AC input may be obtained from the watt hour meter mounted on the pole. To do this, count the number of revolutions made by the watt hour meter in so many seconds, multiply by the meter constant stamped on the meter times 3600 and divide by the number of seconds timed. This gives AC input in watts. Then go ahead and use the formula as above.

Example: A rectifier unit does not have a watt meter. The wheel of the watt hour meter revolves 11 times in one minute. Meter constant is shown as 1.8. Output of the rectifier is the same as in the first case, 50 amperes at 15 volts DC.



$$\text{AC watts} = \frac{K \times N \times 3600}{T}$$

where K is the meter constant and N is the number of meter revolutions in T seconds.

$$\text{AC watts} = \frac{(1.8)\ (11)\ (3600)}{60} = 1188 \text{ watts AC}$$

$$\text{Efficiency} = \frac{(15)\ (50)\ (100)}{1188} = 63 \text{ percent.}$$

$15 Per Rule of Thumb

These formulae from the pages of engineers' own notebooks yield rough, but reasonably accurate answers for design, maintenance and supply questions. The Editors will pay $15 for your pet Rule of Thumb. Send your Rule of Thumb to Donald M. Taylor, Editor, PIPE LINE INDUSTRY, P. O. Box 2608, Houston 1.

How to do it

PIPE LINE HINTS

$10 is paid for each illustrated acceptable contribution. Mail to The Editor, PIPE LINE INDUSTRY, P. O. Box 2608, Houston 1, Texas

Creek Crossing Supported by Cable and Frame Under Pipe

A simple creek crossing may be built by placing supporting members under tension beneath the pipe rather than having a catenary above. To construct it, A-frame supports are set in cement on each side of the creek, well back from the bank.

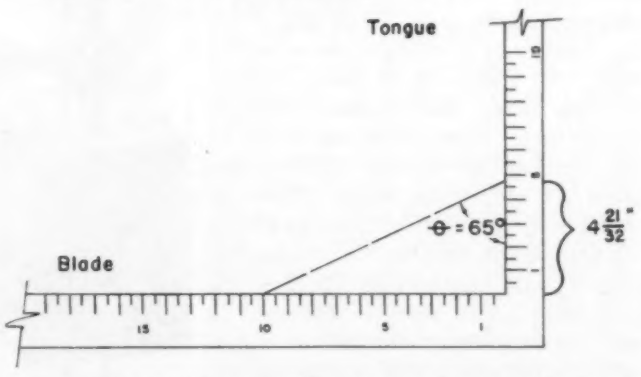
Pipe is pulled across the creek and triangular frames are welded to the bottoms as shown. Holes drilled in the lower section of the frames hold ¾-inch wire cables. A plate is welded and braced on each end of the swinging joint. Bolts fastened to the ends of the cables pass through the holes in these plates.

When nuts are tightened against the plates the cable is put under tension. The pipe then becomes rigid enough to be lifted into the A-frame saddles with a winch truck. It is welded into the line using 45 degree risers to allow for expansion and contraction of the line.

How to Lay Out an Angle with a Carpenter's Square

All you need is an ordinary carpenter's square and a trig table. To lay out the angle with these two tools, first do a little arithmetic. If the angle is greater than 45 degrees, subtract it from 90 degrees; if less than 45 degrees, read directly. Look up the tangent in the trig table; multiply this by 10. Convert this product to inches and mark the distance off on the blade of the square. (If the angle is greater than 45 degrees, mark off on the tongue as shown.) Connect to the 10-inch mark on the opposite scale to get the angle.

As an example, to lay out an angle of 65 degrees, first subtract this from 90 degrees, giving 25 degrees. The tangent of 25 degrees is .4663. Multiply by 10 and the answer is 4.663. Measure this off in inches on the tongue and connect to the 10-inch mark as shown.

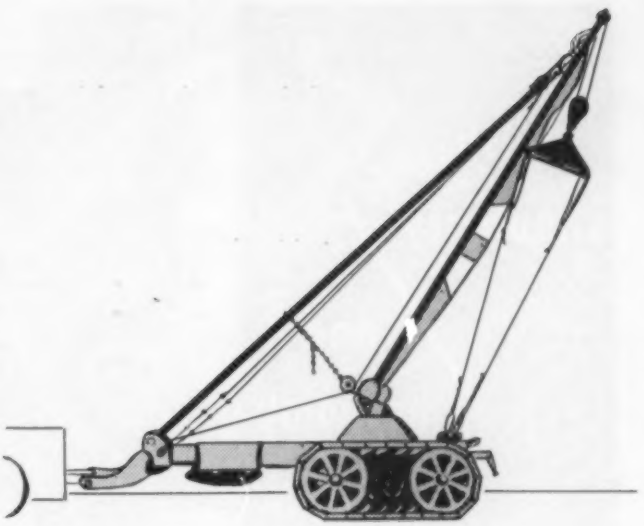


Gin Pole on Half Track Handles Large Pipe Easily

Large diameter pipe may be moved safely about the job with the half track boom assembly shown here. The rig is designed not only to give a light truck a mechanical advantage large enough to handle heavy pipe, but also to provide height necessary to carry 40-feet lengths of pipe.

Pipe is held by chime hooks at the ends. A heavy steel spreader bar attached to the gin pole block prevents excessive tension on the slings. This gives additional protection to the pipe ends.

The entire assembly is mounted on salvaged army half-tracks. A strong-back made of steel plate and hog rod reinforces the gin pole. It may be rigged to handle various size pipe at any height up to the top working height of the gin pole. Tracks permit work over rough ground and a wide range of soil conditions.



Jet Drilling with Water Speeds Anode Installation

Use of a high velocity water jet is an effective and quick method of drilling holes for cathodic protection anodes in sandy soils. An engine-driven rotary pump supplies water through 100 feet of 1¼-inch hose and a 9-foot length of pipe to the jetting nozzle.

The high silicon-iron anode, 60 inches long and 2 inches in diameter, was started as shown in Figure 1. Thirty seconds later it was 4 feet in the ground, and it only took one minute to bury it to the full depth of 9 feet.

Jetting anode holes works well in quicksand or very sandy soils where it is nearly impossible to dig holes with conventional rotary drilling equipment. It is especially suitable in creek bottoms and other places inaccessible to ordinary drilling machines. A smaller portable gasoline pump can be used there. The method is a time and money saver. (Abstracted from June 1955 CORROSION.)

The pumping equipment . . .

Here's how it works . . .

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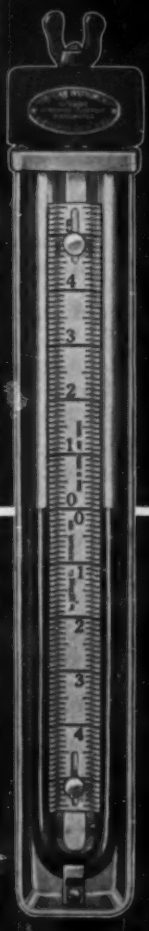

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HINTS . . .

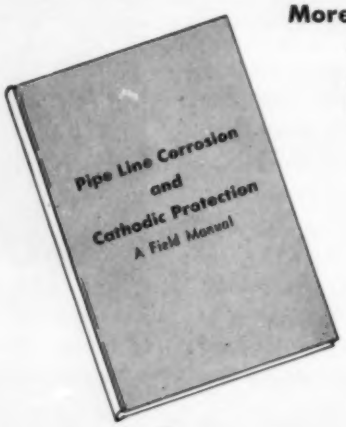
Rig Truck for Heavy Field Duty

A few shop-built additions will make a pick-up service truck capable of handling tough field jobs. To provide power for pulling and loading equipment, install a winch, driven by a power take-off, in the front of the bed.

At the rear, attach a heavy bumper

More comments on this new Handbook:

"... a most practical on-the-job manual for men concerned with pipe line corrosion. We are ordering copies for each of our district engineers."



Pipe Line Corrosion and Cathodic Protection

By MARSHALL E. PARKER

This Handbook, written by Marshall E. Parker, consultant, is designed as a practical field manual. It is a 108-page pocket-size volume printed first as a popular series in WORLD OIL. The Handbook is illustrated with many charts and drawings and is completely indexed by subjects.

It presents comprehensive data on Soil Resistivity Surveys, Potential Surveys, Line Currents, Current Requirements, Rectifier Systems, Ground Bed Design, Magnesium Anodes, Stray Current Electrolysis, Interference in Protective Systems, Operations and Maintenance, and Coating Protection and Testing.

An appendix has been added of technical data on Underground Corrosion, Basic Principles of Cathodic Protection, Properties of Metals and Attenuation Equations. Order copies of this practical Field Manual now for each of your field men. Price $3.

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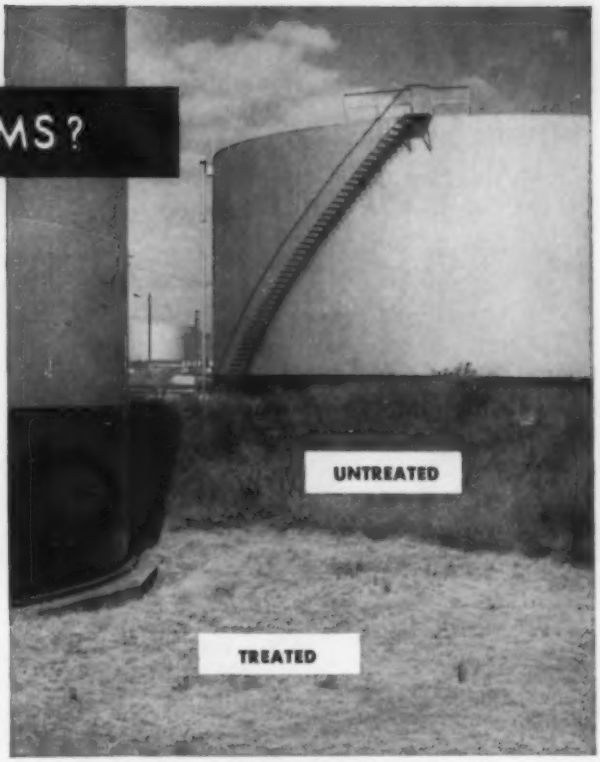

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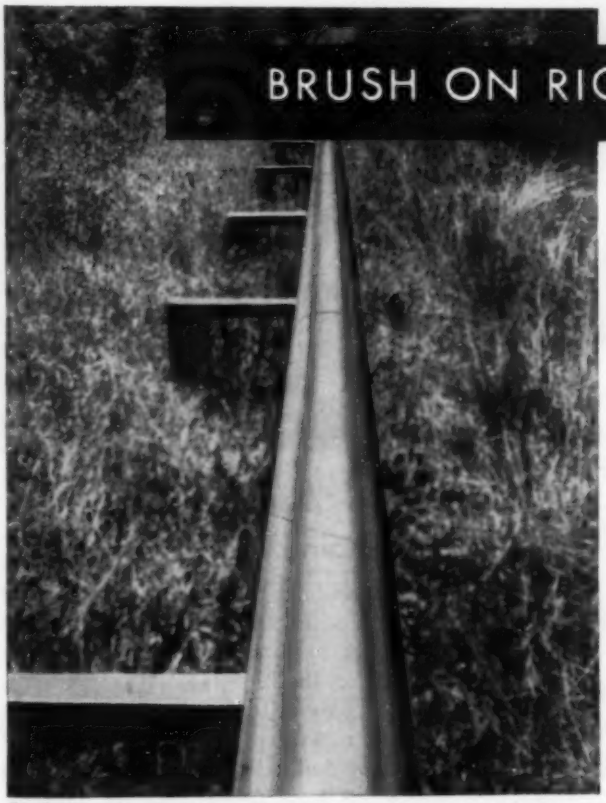
BRUSH ON RIGHT-OF-WAY?



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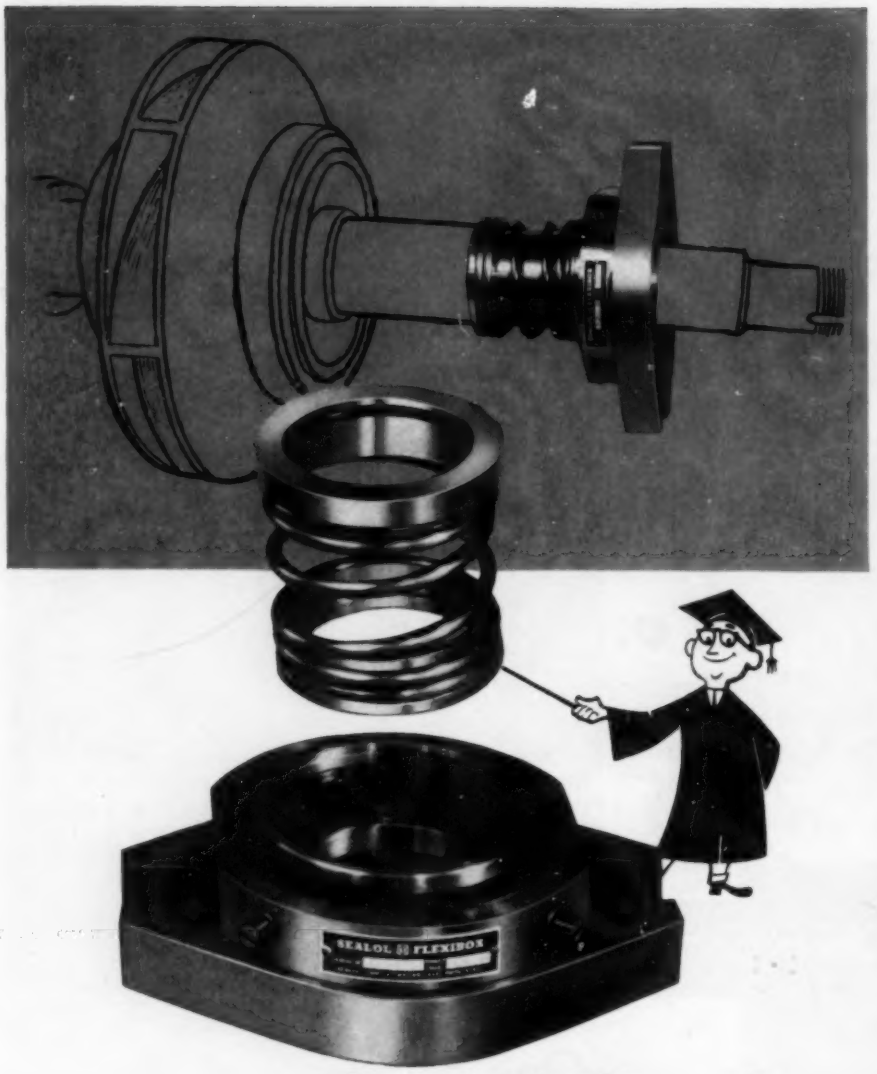

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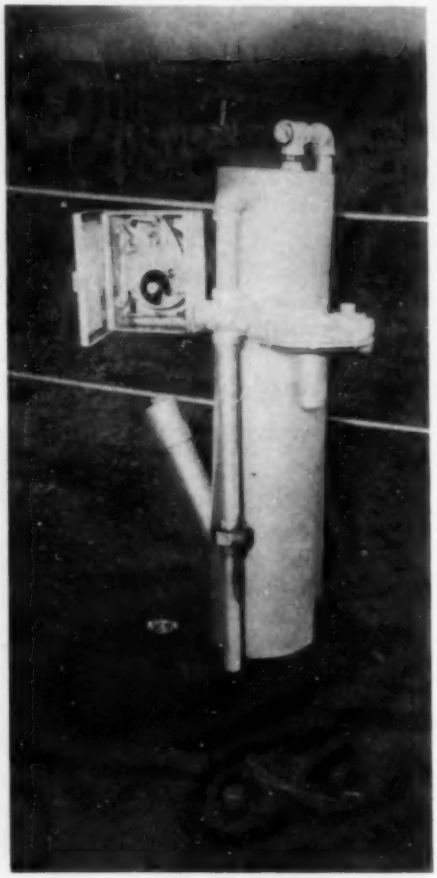
THE BALANCED PRESSURE SEAL

to the frame to aid loading and to protect rear fenders in rough terrain. Weld clevices to the top of the bumper at each end to support gin poles.

Loading heavy equipment is made easier by a roller of 4-inch drill pipe, supported by bearings as shown.

Protect the cab by welding a stout headache post to the frame to provide a rest for long pieces of pipe. Oak planking protects the bottom and sides of the bed for heavy hauling.



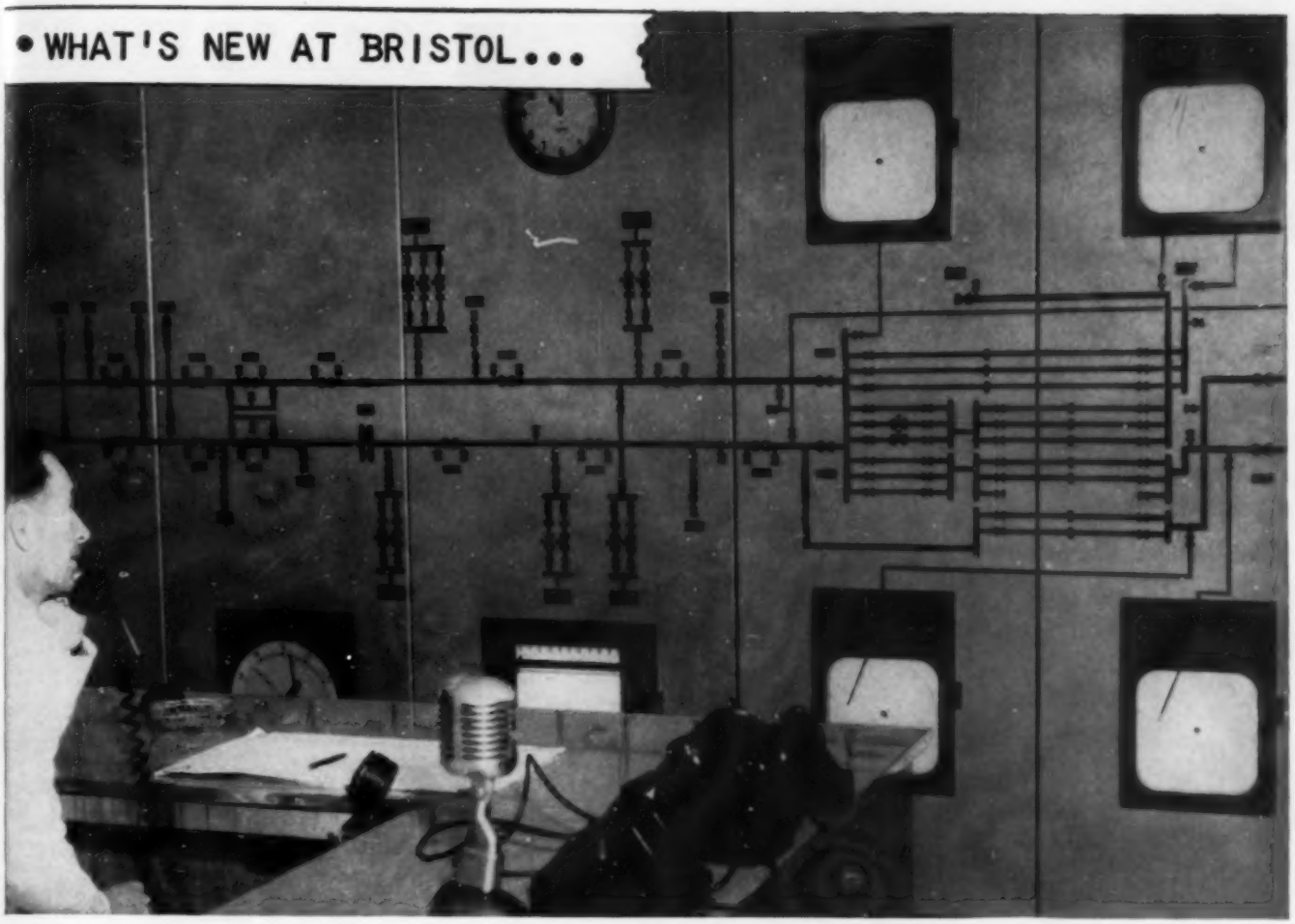
Steel Shavings Clean Gas In Engine Fuel Scrubber

A scrubber for cleaning engine fuel gas at a field pipe line station incorporates an automatic shutdown time clock on the fuel line. The scrubber is made from 10-inch pipe with an outlet line welded to the top. An inlet line welded into the side near the top extends to a point near the bottom.

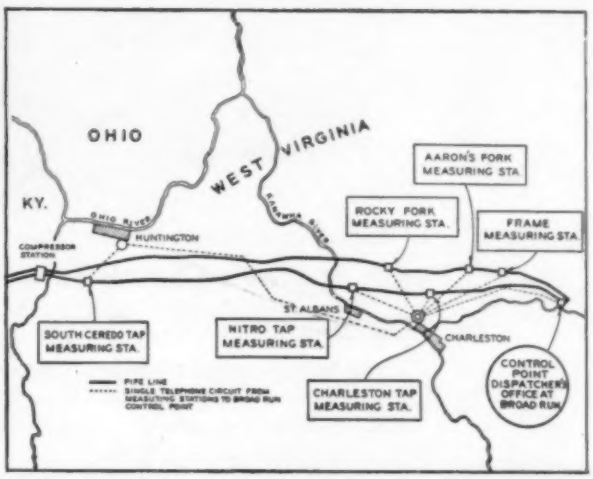
Steel shavings are placed in the bottom of the vessel through a 2-inch nipple welded onto the side as shown. A drain connection is fitted at the bottom.

Gas fuel is cut off by the time clock on the gas regulator at a predetermined time.

• WHAT'S NEW AT BRISTOL...



Now you can dial for pressure readings



MAP SHOWS extent of Tennessee Gas Transmission Company's remote operations — all controlled through a Bristol Metameter Telemetering and Remote Control system over a single 74-mile circuit.

You're looking at the field dispatcher's office in the Broad Run, W. Va., station of the Tennessee Gas Transmission Company.

From this point, TGT controls the pressure, flow, and metering at six delivery points spread along a distance of 74 miles in the mountains of West Virginia. This control is accomplished with the help of a group of Bristol Metameter® Telemeters, *which supervise a total of 51 functions, over a single 74 mile telephone circuit.*

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To accomplish this, the field dispatcher dials in any desired location, and reads the value of the measured function on his Metameter Telemeter receiver. By dialing the proper function, he can also remotely vary the flow controller on each meter tube, from no-flow to maximum flow.

Bristol has become the acknowledged leader in the telemetering field, in the opinion of thousands of leading companies throughout the country. Our bulletin M1710 tells why. Write for it today. The Bristol Company, 114 Bristol Road, Waterbury 20, Conn. 5.1

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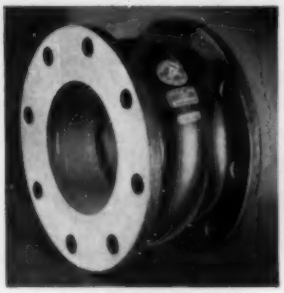

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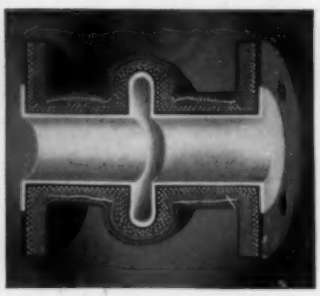
Rubber Expansion Joint

Rectangular-type
Rubber Expansion Joint

U-type
Rubber Expansion Joint

There's a GARLOCK EXPANSION JOINT for your piping applications

All-Teflon*
Expansion Joint



Rubber Expansion Joint
with Teflon liner

Expansion Joint for use on
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Garlock manufactures a *complete* line of expansion joints specifically designed to meet the requirements of different types of service. **Rubber Expansion Joints** are made in all pipe sizes from ¾" to 72" for water, air, or exhaust steam. They are furnished in round, rectangular, tapered or offset; spool-type and U-type.

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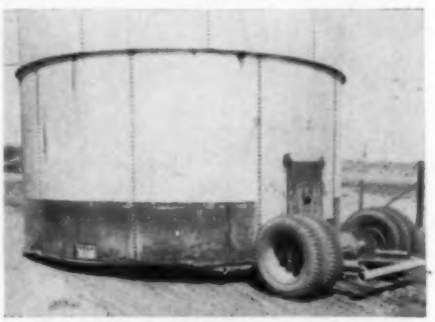
Valve Lifted:
Piston:
Spring:
Increased Gas:
Decreased Gas:
Station:

Signed

Use Rubber Stamp Form To Record Engine Data

In taking pull cards on two-cycle engines, it is often hard to get each operator to list all information on back of indicator cards, and it requires time to write down each item.

To overcome this, a rubber stamp can be made up showing readings desired. Each entry can be filled in quickly after back of indicator card has been stamped. The completed card provides a good record to refer to in keeping two-cycle engines balanced.



Field-Fabricated Lowboy Aids Moving Small Tanks

A special lowboy which can be field-fabricated makes moving stock and small storage tanks a simple matter. This lowboy can be made from the back wheels of a heavy-duty bobtail truck and 4-inch pipe.

Weld the frame which supports the tank to the underside of the truck axle. Support the pipe framework that goes beneath the tank with two pieces of 6-inch pipe running the length of the trailer. Connect these, in turn, to a trailer hitch.

To load the tank onto the lowboy, tilt the tank and pull the trailer beneath it. During travel, a chain around the base of the tank will steady it.

TRACTOR-TYPE CRAWLERS OFFER GREATER MOBILITY TO PIPELINERS

Provide Important Advantages for Traveling Over Rugged and Steep Terrain

Performance reports on 15-B and 22-B excavators equipped with special tractor-type crawlers prove the value of this mounting on pipeline jobs. From New Mexico we've received this typical report:

"The country was rocky and, in places, the hills were so steep that tractor winches were needed both as an anchor in digging, and also to let the backhoes down the slopes when digging was completed. I noticed that the tractor-type treads on the 22-B's allowed them to travel and dig unaided in many places where machines, equipped with conventional treads, were helpless without tractors and winches."

And the ditch foreman on this spread says:

"Bucyrus-Erie machines stand up better on tracks, travel better, and the road gear saves time. I like the new tractor-type treads on hills, slick places, and on snow. They have more clearance and don't high center on rocky roads. The sealed bearings are also a very good feature."

That's the story. Equipped with sure-gripping crawlers, 15-B and 22-B dragshovels can climb grades as steep as 35%. Deep grousers provide sure traction. Ground clearance under housing is 16½" for 15-B and 20¾" for 22-B — enough to permit travel over stumps and other low obstructions. Special positive sealing protects all track-roller bearings from water, dust, grit, and dirt.

See your nearby Bucyrus-Erie distributor for details.

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Humble RUST-BANS *will save you money*

Check this list carefully.

Then check your own equipment; see if you have overlooked vital spots where RUST-BANS can help you save on maintenance costs.

Here are typical types and uses of RUST-BANS and other Humble Protective Coatings:

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For priming all types of vessels and structures
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☐ ***Aluminum Coatings and Enamel Finishes:***
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For coating hot surfaces, like manifolds and exhaust stacks at temperatures up to 1000° F.

☐ ***Rust Preventive Compounds:***
For preserving stock inventories . . . items in bin storage
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- *Call on the Sales Technical Service Division for expert advice on your corrosion problems. No obligation, of course.*

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HUMBLE

HINTS . . .

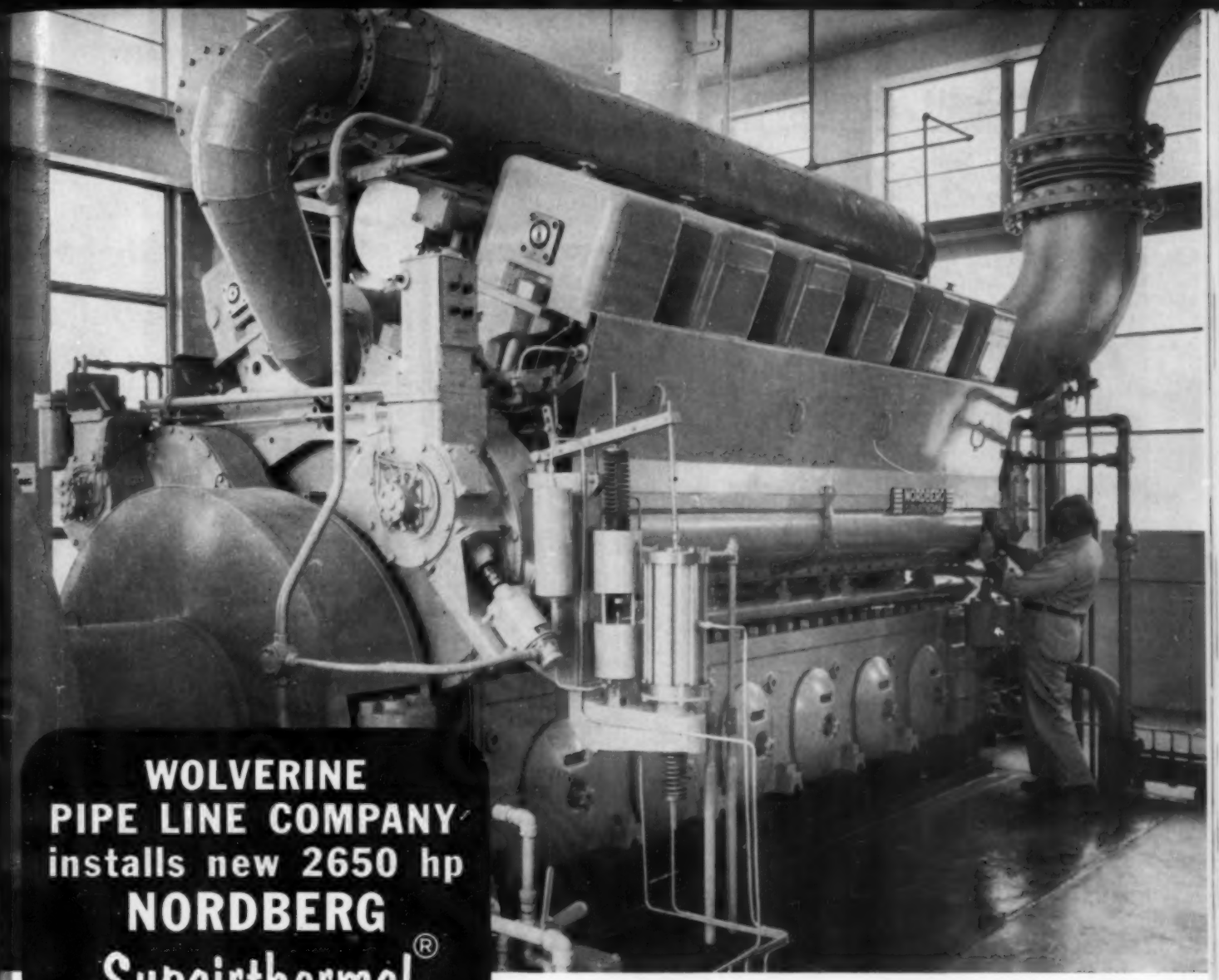
Steps Aid in Servicing Elevated Engine Radiator

Maintaining full radiators on engines in field service is important when these engines are located in remote areas and operated continuously. It is a big help to those with the responsibility of such maintenance items if the job is made easy. By adding steps to the front end of this elevated engine radiator, the job of filling the radiator was greatly simplified.

The metal steps shown above were fabricated in the welding shop of salvaged material. The footing surfaces are pieces of scrap floor plate to which a border of angle iron was welded to serve as a support. The three steps were joined by outside pieces of strap steel that were bolted to the outside shell of the radiator. A stiff leg or support was welded to the underside of the middle step and equipped with a saddle which fitted over the front cross member of the engine skid. This leg is not fastened to, but merely rests on, the cross member.

The entire step assembly can be mounted or dismounted in a matter of minutes by removing the two connecting bolts to the heavy radiator shell.

For more data on advertised products, use Readers' Service Cards, last page.



WOLVERINE PIPE LINE COMPANY installs new 2650 hp NORDBERG Supairthermal® V-TYPE ENGINE

Wolverine Pipe Line Company products pipe line begins at Hammond, Ind. and runs eastward to a point near Ann Arbor, Mich., where it branches and continues to Detroit and Toledo.

THE new Wolverine Pipe Line System is a 295-mile, 16-inch products carrier which combines modern design and engineering features unique in the history of the pipe line industry.

Capable of delivering 4,000,000 gpd, the line currently has two pumping stations—one at Hammond, Ind. and one at Vicksburg, Mich. All power for the Vicksburg station is delivered by a 12-cylinder Nordberg V-Type *Supairthermal* Diesel, driving a centrifugal pump rated 3220 gpm through a 10:1 speed increasing gear. Currently rated 2650 bhp at 500 rpm, the *Supairthermal* engine will later be modified to develop 3200 bhp when additional line capacity is desired. This will then be the largest engine ever installed on a pipe line.

Here is one more example of the kind of compact, efficient power generation that Nordberg *Supairthermal* engines are delivering to the pipe line industry. Write for further information, outlining your power needs.

NORDBERG MFG. CO., Milwaukee, Wis.

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DIESEL • DUAFUEL® AND SPARK-FIRED GAS ENGINES

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0334

World Wide Photo

Francis Kernan, right, of White, Weld & Company presents checks totaling $20,829,742.50 to C. R. Williams, center, president of Pacific Northwest Pipeline, and Leon M. Payne, left, vice president and secretary of the pipe line as financing plans were arranged. Construction is now under way on the 1466-mile line.

Pacific Northwest Begins Construction, Seeks FPC Approval for Canadian Gas

The past month has been a busy one for Pacific Northwest Pipeline Corporation. To start it off, the Securities and Exchange Commission approved a financing program to raise $162 million for construction of the 1466-mile pipe line from Ignacio, Colo., to Bellingham, Wash.

Financing plans call for a public offering of 287,000 units consisting of one share of common stock and one 5½ percent $60 interim note. Each unit will be offered at a price of $72.

In addition to the public offering, Pacific Northwest is offering present holders of common stock the opportunity to buy 1,549,100 shares of new common stock at a subscription price of $10 per share. Bulk of the financing will come from an agreement entered into with institutional investors providing for the issuance of $93,200,000 of 4½ percent first mortgage pipe line bonds due in 1975.

Balance of the financing program involves agreements providing for issuance of $26,800,000 of 3½ percent unsecured notes to banks, due serially from 1958 to 1962, and issuance of $6,329,000 in payment for lease rights in the San Juan Basin.

Soon after financing was arranged, construction contracts were let for the first 655 miles of line. Work on these contracts, totaling $11,236,000, is now under way.

Eight sections of the main line between Ignacio, Colo., and Burley, Idaho, were contracted. These sections will be made up of 387 miles of 26-inch and 268 miles of 22-inch. Contractors working on these first sections are:

Sections 1 and 2—150 miles of 26-inch, between Ignacio, Colo., and Moab, Utah, River Construction Corporation, Fort Worth, Texas.

Sections 3 and 4—160 miles of 26-inch, between Moab, Utah, and Jensen, Utah, R. H. Fulton & Company, Lubbock, Texas.

Section 5—77.6 miles of 26-inch, between Jensen, Utah, and a point southwest of Green River, Wyo., Associated Pipeline Contractors, Inc., Houston, Texas.

Section 6—82.8 miles of 22-inch, between a point southwest of Green River, Wyo., and Sage, Wyo., A. J. Curtis Construction Company, Casper, Wyo.

Section 7—90 miles of 22-inch, between Sage, Wyo., and Lava Hot Springs, Idaho, B & M Construction Corporation, Oklahoma City.

Section 8—95 miles of 22-inch, between Lava Hot Springs, Idaho, and a point east of Burley, Idaho, Midwestern Constructors, Inc., Tulsa.

Contracts for another 300 miles of line will be let soon. Next sections let will be across northeastern Oregon to the Columbia river and along the river to Vancouver, Wash.

The initial system is scheduled for completion in the latter part of 1956. Gas will be delivered through a part of the system late this year. When the line now authorized is completed it will have a delivery capacity of 343,000 Mcf per day.

Pacific Northwest expects to produce the major portion of this from oil and gas leases covering approximately 460,000 acres in the San Juan Basin. Seventy-seven gas wells have been completed and an additional 144 will be drilled prior to the completion of the pipe line.

Expansion proposal before FPC. Fall construction of the Columbia river section of the line would depend upon FPC approval of an export license to connect with Westcoast Transmission Company Ltd. near Sumas, Wash.

If approved, Pacific Northwest will import up to 300,000 Mcf per day from Westcoast and export minor quantities to British Columbia. This recent request asks authority to serve an additional 14 communities in Washington and Idaho, and to export gas to Vancouver and Trail, B. C. Bulk of the gas from Westcoast would be delivered to El Paso Natural Gas Company at Mountain Home, Idaho, for transmission to the California markets.

To receive the Canadian gas, Pacific Northwest proposes to extend its line from Bellingham to a connection with Westcoast near Sumas, Wash. Added facilities would boost the length of

LADISH *Developments*

FOR THE PIPE LINE INDUSTRY

● **3-R (EXTRA LONG RADIUS) ELBOWS**

Special Fittings Designed from Field Research Solve the Industry's Unusual Piping Problems

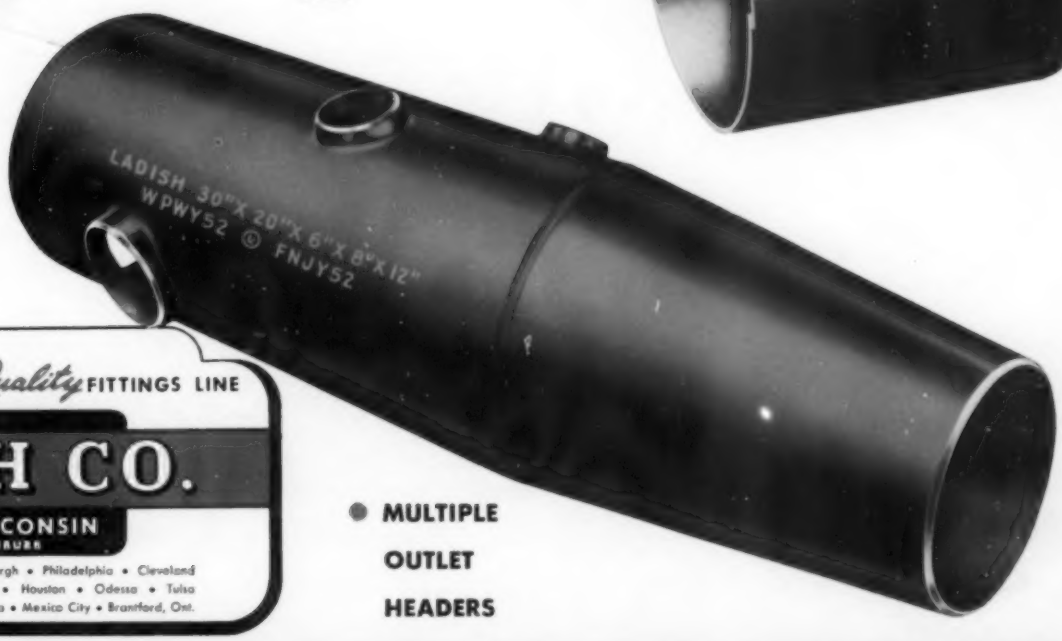
Working closely with pipe line engineers, Ladish continues to pioneer fittings designed to simplify and improve transmission efficiency.

Notable examples are: 3-R Elbows to reduce frictional losses and to facilitate cleaning . . . Hot-Tap Reinforcing Tees in choice of designs to improve reinforcement of horizontal or vertical branch connections . . . Multiple Outlet Headers to reduce cost and simplify installation of gate settings . . . and Anchor Flanges to restrict pipe movement.

Reliability of all Ladish fittings is assured by unexcelled metallurgical standards of Controlled Quality.

● **ANCHOR FLANGES**

● **HOT-TAP REINFORCING TEES**



● **MULTIPLE OUTLET HEADERS**

TO MARK PROGRESS

THE COMPLETE *Controlled Quality* FITTINGS LINE

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The TEIA Underwriter is a specialist in Workmen's Compensation Insurance, with a thorough understanding of the employer's problems and the special provisions of the Texas Workmen's Compensation Law.

Let the TEIA Underwriter and the SERVICE TEAM, of which he is a part, work with you . . . to improve your Workmen's Compensation Insurance coverage and service . . . and SAVE you money.

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FORT WORTH • FREEPORT • GALVESTON • HARLINGEN • HOUSTON • LUBBOCK • MIDLAND
ODESSA • PORT ARTHUR • SAN ANGELO • SAN ANTONIO • SHERMAN • TYLER • WACO • WICHITA FALLS

TEXAS EMPLOYERS INSURANCE ASSOCIATION
HOME OFFICE - DALLAS, TEXAS

transmission line to 1487 miles, made up of 680 miles of 22-inch and 807 miles of 26-inch. Two new compressor stations are proposed, a 5280 horsepower station at Seattle and a 8800 hp station near Sumas.

With these additions Pacific Northwest will increase capacity from the presently authorized 342,950 Mcf to 645,173 Mcf per day. Of this increase, 250,000 Mcf would be delivered to El Paso Natural. Until the Westcoast line is completed, a limited quantity will be exported to Canada. Cost of the proposed addition of facilities is estimated at $28,123,456.

American Louisiana Suppliers Approved by FPC

The 1289-mile Louisiana to Detroit line of American Louisiana came a step closer to construction with the recent FPC issuance of certificates to four independent producers who will supply natural gas for the line. Last fall, FPC authorized the line on the condition that producers who were to supply gas would apply for and obtain certificates. Of the original six producers only Superior Oil Company, Kerr-McGee Oil Industries, Stanolind Oil & Gas Company, and British-American Oil Producing Company applied. These producers together with supplies available from Texas Gas Transmission Corporation have sufficient reserves to meet American Louisiana requirements, the FPC observed.

Close on the heels of FPC approval, Panhandle Eastern Pipe Line Company filed a brief with the FPC charging that the application had been granted without giving Panhandle Eastern an opportunity to question gas suppliers, and that American Louisiana had not presented a satisfactory financing plan. Panhandle Eastern had previously filed an appeal of the conditional FPC approval with the U. S. Supreme Court.

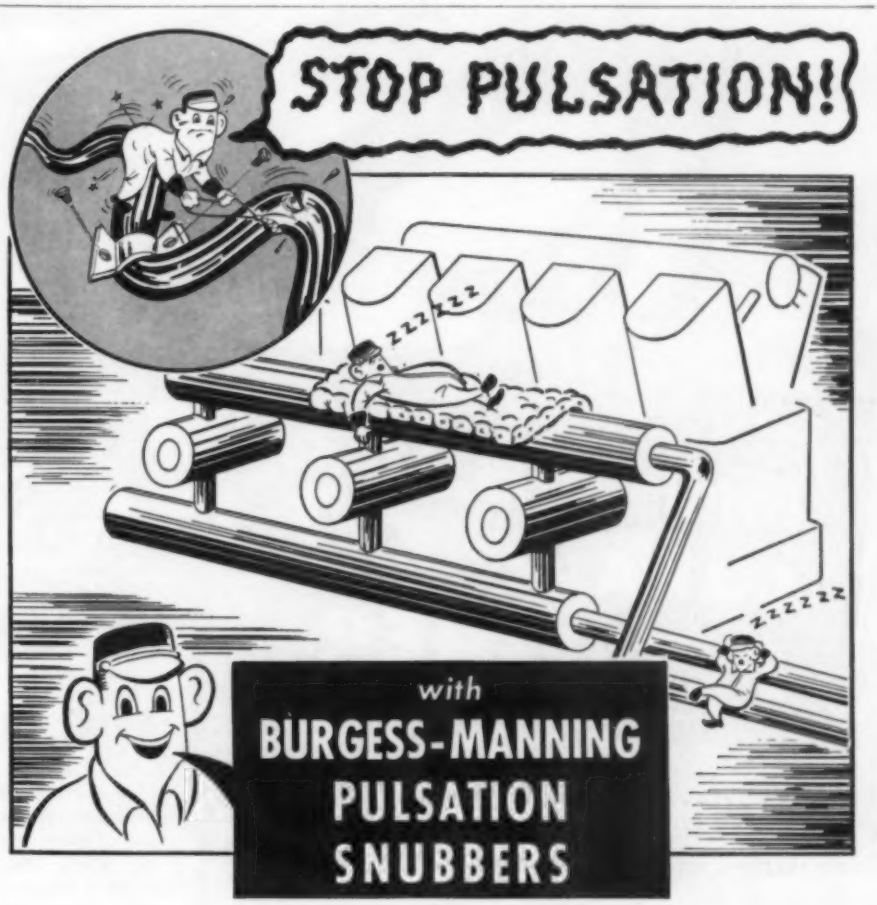
Texas Eastern, Penn-Jersey File Station Shift Plans

Texas Eastern Transmission Corporation and Texas Eastern Penn-Jersey Transmission Corporation have jointly filed an application with the FPC requesting authority for shifts between the two systems and construction of additional horsepower.

If approved, 10,000 horsepower, either presently installed or authorized on the Texas Eastern system at Phoenixville, Chambersburg and Wind Ridge, Penn., will be shifted to the Penn-Jersey system. Texas Eastern will then construct an additional 3300 reciprocating horsepower at its Linden, N. J., station and lay 11 miles of loops in the Philadelphia area. To complete the expansion, Penn-Jersey will build a 5000 hp gas turbine centrifugal station at Perulack, Penn., and a similar 5500 hp station at Grantville, Penn.

Proposed facilities will give greater flexibility in the Philadelphia-New Jersey delivery area with increased peak load capacity. Total capacity of the joint system is now about 1,366,500 Mcf of gas per day with about 731,000 Mcf available east of Oakford Storage. If approved, the additional facilities would boost this capacity east of Oakford to 843,000 Mcf per day, an amount the Texas Eastern companies consider adequate for anticipated 1955-56 peak demands.

Cost estimates for the project are: Texas Eastern—$2,597,400 and Penn-Jersey—$2,836,000.



Burgess-Manning Pulsation Snubbers will remove one of your most aggravating and costly bug-a-boos, that of line surges from compressors, pumps, blowers, etc. Maintenance and service costs will drop sharply — lines and associated equipment will operate at a new efficiency — flow control can be greatly improved. Structural supports of pipe lines need no longer be of costly and special construction — gas compressors and pumps will deliver full design flow with greatest efficiency in pulse-free piping.

Send us your specifications for recommendations

BURGESS-MANNING COMPANY

Sound Engineering

713 East Park Avenue, Libertyville, Illinois

Dallas, Texas

For more data on advertised products, use Readers' Service Cards, last page.

TAKE OVER THESE

POWER CONTROLS

FOR GREATER OPERATING EASE

... FASTER RESPONSE

Presenting the NEW 26 LORAIN PIPELINER

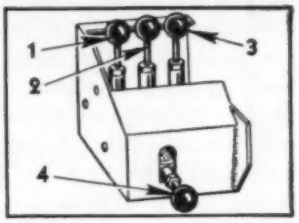
Mr. Pipeliner . . . you asked for it! This new "Power Controlled" Lorain-26 Pipeliner has everything you have wanted in a more powerful, faster digging, easier operating Hoe. Now, new "E-Z" action operating levers reduce operator effort by 70%. Now, Hydraulic Power goes to work (see right) on all crawler controls. Now, the new "26" brings you a longer, stronger hoe boom; newly designed, sturdier, wider 2-speed crawlers with 29-inch treads. Throughout the "26" there's new power, new clutches for operating ease and long life.

Investigate the new Lorain-26 Pipeliner now . . . plan to put it on your next pipeline job. Your Thew-Lorain Distributor can give you the big, new story in detail!

THE THEW SHOVEL CO., LORAIN, OHIO

NEW... Hydraulic Power Crawler Controls

Here's more operating ease and quicker response in the new Lorain "26". From the operator's cab — with turntable in any swing position — the operator simply flicks these levers—and these actions take place immediately . . .



1. HOUSE LOCK is engaged promptly by power and released instantly by this handy, easy-acting lever, to prevent side motion of turntable.

2. SWING AND TRAVEL JAW CLUTCHES are selected and engaged by simply flipping this lever . . . push forward to travel . . . pull back lever to swing.

3. LOCKING PAWLS, now fully enclosed and mud protected, are instantly engaged and released by fast-acting power.

4. CRAWLER STEERING is power controlled by a single short lever — no operator effort, no fatigue. Either right or left steering is effected while traveling forward or backward, with turntable in any position of swing.

THEW-LORAIN 26 PIPELINER

For more data on advertised products, use Readers' Service Cards, last page.

Atlantic Seaboard to Lay 84 Miles of 26-Inch Line

The FPC has authorized Atlantic Seaboard Corporation of Charleston, W. Va., to construct 84 miles of pipe line and 2000 additional horsepower.

Seaboard will parallel sections of its existing line from Cobb, W. Va., to Baltimore with 26-inch loops at points in West Virginia, Virginia and Maryland. Compressor facilities will be increased by a 2000 horsepower installation at Seaboard's Cleveland, W. Va., station.

When completed, the new facilities will enable Seaboard to meet estimated peak-day loads for the winter of 1955-56. Present capacity is considered about 70,500 Mcf per day inadequate, report company officials. Total estimated cost of the project is $9,281,500.

Transok Pipe Line Plans 140-Mile Line to Tulsa

Transok Pipe Line Company of Tulsa has begun construction on 140 miles of 24-inch line to carry gas from south central Oklahoma fields. Bulk of the gas will be delivered to Public Service Company of Oklahoma's Tulsa station. The line is being constructed by Pipe Line Service Company. Transok has filed a mortgage on the line for $13.5 million.

Phillips Petroleum Company and Magnolia Petroleum Company will supply over one trillion cubic feet of gas to Transok under a 25-year contract. Producing companies will operate the gathering and field compression facilities to deliver gas at 700 pounds per square inch pressure.

Union Oil Completes 65-Mile Crude Oil Line

Union Oil Company's 12-inch, 65-mile crude oil pipe line between the Torrey lease and its Los Angeles refinery was completed in May. Having a capacity of 50,000 barrels per day, the line eliminates transportation of crude from Ventura by tankship, and results in the reduction of one vessel from the tanker fleet.

The line carries crude from the company's Torrey-Oakridge-Simi area as well as from other fields in Ventura, Santa Paula and Del Valle areas. The line was financed by the Santa Clara Valley Pipe Line Company and leased to Union Oil under a long-term lease arrangement.

He's doing it Quickly and Correctly with a

LOWELL #50-A Reversible Ratchet Wrench

Here's why many major pipe line companies are asking for the new Lowell #50-A Wrench.

1—The reversible ratchet speeds installation of mechanical pipe line couplings.

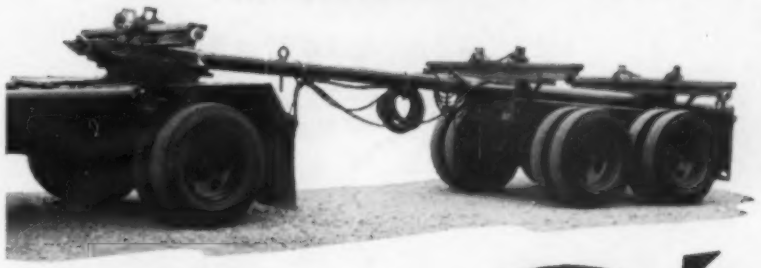
2—Its special 8" handle assures correct torque on 5/8" bolts.

Other reversible ratchet wrenches available with handles up to 36" lengths.

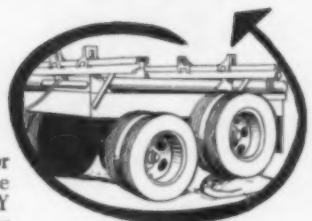
Be sure of the right wrench for pipe line jobs . . . ask your industrial distributor for the #50-A or other Lowell Series 50 Wrenches.

LOWELL WRENCH CO.
WORCESTER 8, MASSACHUSETTS

TOP QUALITY PIPELINE TRAILER



THE LOADCRAFT PIPELINER



DOUBLE PIVOT TANDEM PRINCIPLE

At last here's a top-quality tandem trailer for the pipeline industry that is really built to take the cross-country hikes. The axles will STAY in alignment. Quality that has made Spencer Trailers popular with the oil fraternity for over 38 years goes into each of these jobs.

Double pivot tandem keeps load in balance in rough terrain, reduces wear and tear on axles and tires Hi-tensile pressed steel frame, wood surface block-type bolster plus other exclusive features gives you the kind of trailer you have needed . . and at a price that is less than you would expect to pay for such high quality.

Spencer-Safford LOADCRAFT
AUGUSTA, KANSAS

Please send me information on your
Pipeliner___ Pole Trailer___ Oil Field Float___
NAME_____
ADDRESS_____
TOWN_____ STATE_____

For more data on advertised products, use Readers' Service Cards, last page.

El Paso Natural Submits Triple Proposal to FPC

Another major gas pipe line construction project is being planned west of the Rockies. El Paso Natural Gas Company has filed an application with the FPC, requesting authority to construct facilities for delivering an additional 550,000 Mcf per day to its customers. To do this El Paso presented three proposals. All involve the connection of El Paso with the new Pacific Northwest Pipeline Corporation line just under way.

El Paso proposes to exchange natural gas at well head connections from its Mesa Verde wells in the San Juan Basin with Pacific Northwest at the rate of 100,000 Mcf per day during each of the first three years of Pacific Northwest's operation. The fourth year, 60,000 Mcf would be exchanged; and 40,000 Mcf exchanged the fifth year. Pacific will return gas from its well head connections in the San Juan Basin at a rate of not more than 50,000 Mcf per day commencing with its seventh year of operation.

To carry out the proposal El Paso will construct and operate facilities for production of 100,000 Mcf per day for exchange over a five-year period beginning about July 1, 1956. In addition El Paso will construct and operate facilities for producing, gathering, processing and transmitting 500,000 Mcf from the San Juan Basin and 50,000 Mcf from the Permian Basin to present customers.

California customers will receive the bulk of the additional production. Southern California Gas Company and Southern Counties Gas Company will jointly use 225,000 Mcf; Pacific Gas and Electric Company will receive 225,000 Mcf; Nevada Natural Gas Pipe Line Company will get 30,000 Mcf, and the remaining 70,000 Mcf will go to El Paso's own system.

In its first proposal El Paso requested 468 miles of 34-inch loop line from its Blanco, N. M., plant to the Colorado river. The river would be crossed with an aerial crossing near Topock, Ariz. El Paso will install an additional 14,000 horsepower at its Leupp, Ariz., compressor station, 12,000 hp at its Gallup, N. M., station, and build a new 1760 hp compressor station "Franconia." Field additions will include 34.1 miles of 24-inch line from Pacific Northwest to El Paso Natural near Ignacio, Colo., and 36.3 miles of 12¾-inch from Pampa to Dumas, Texas. These facilities, called Plan "A," are estimated to cost $184,750,000.

As one alternate, El Paso would deliver 650,840 Mcf to its California customers by constructing a 370-mile line from a Pacific Northwest connection at Mountain Home, Idaho. Gas would then be delivered to California customers at a point near Reno, Nev. Cost of this construction is estimated at $204,567,000.

Another proposal calls for the purchase of 250,000 Mcf from Pacific Northwest at a connection near Pendleton, Ore., for transportation to El Paso's California customers at Klamath Fall, Ore. Costs estimated for this proposal is $199,353,000.

If the first proposal is approved, the two southern California companies will jointly construct a 30-inch line from Topock to Los Angeles. This line to be built in three steps will cost about $31 million.

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CORROSION PROBLEMS
SURVEYING
ENGINEERING
INSTALLATION
MAINTENANCE
IN
OUR HANDS
Our business is corrosion control . . . in gas distribution systems . . . pipe lines . . . tank bottoms . . . flow lines . . . oil well casings . . . heater treaters . . . marine installations. Wherever there is a profit loss due to corrosion, Pipe Line Anode Corporation offers you experienced engineering service with the ability to integrate our services with any cathodic protection problem you have.
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11102 Jasper Avenue
Edmonton, Alberta
Pipeline Supply Company
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Houston, Texas
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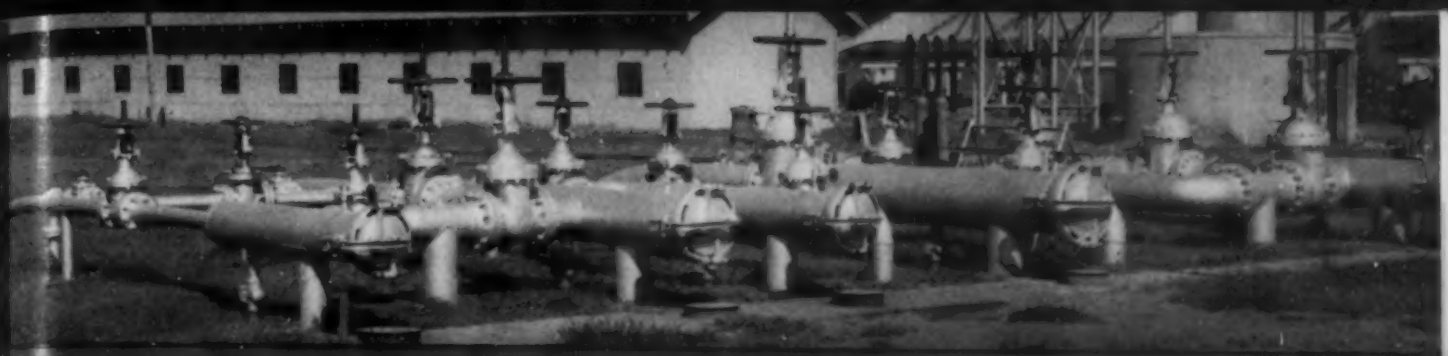
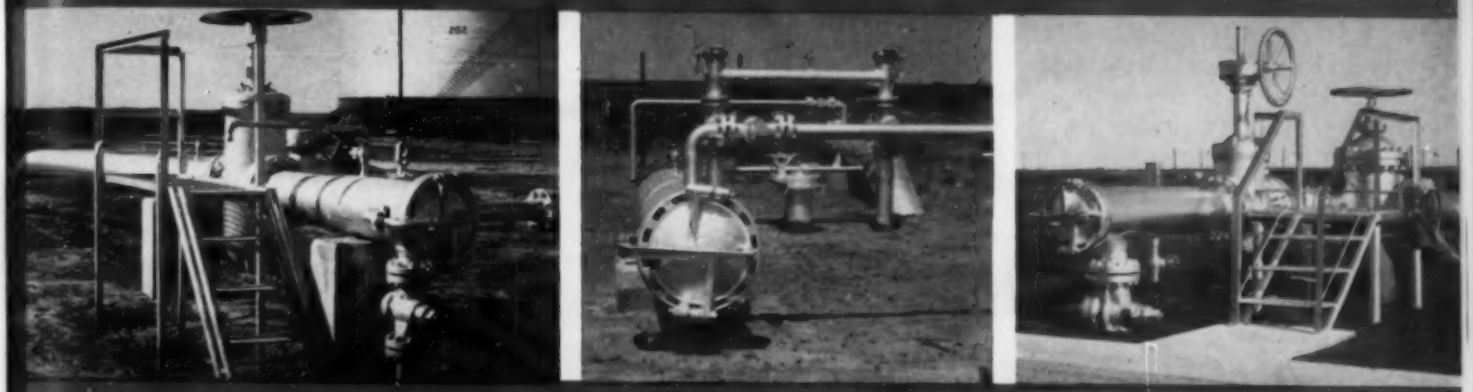


The handiest, safest way to



start and catch a pig....

Unibolt Hinged Scraper Traps

All you need do to open the UNIBOLT Hinged Scraper Trap is release two bolts and the blanking plug swings open like a door. No heavy lifting. Nothing to fall on workmen. No time-consuming blind flanges to make up. No danger of leaks—the UNIBOLT self-sealing oil-resistant gasket, which seldom needs replacement, assures a pressure-tight seal and low maintenance.

Many operators fabricate UNIBOLT Hinged Scraper Trap closures on an oversize barrel in order to facilitate starting the pig. Thus, line pressure does the heavy work.

Wherever multi-bolt flanged couplings and closures are now being used . . . on strainers, scrubbers, mist removers, terminal manifolds, blowdowns or other pressure vessels . . . UNIBOLT Couplings will serve you better.

THORNHILL CRAVER CO.

P. O. BOX 1184 HOUSTON, TEXAS

TGT Seeks FPC Approval For 221-Mile Loop Addition

The Tennessee Gas Transmission Company has asked FPC for authorization to build a $56 million addition to pipe lines and compressor facilities. Included are 221 miles of parallel line, 12,540 horsepower added at new and existing stations, and an extension of the present gathering system into the southeast Louisiana and Mississippi river delta areas.

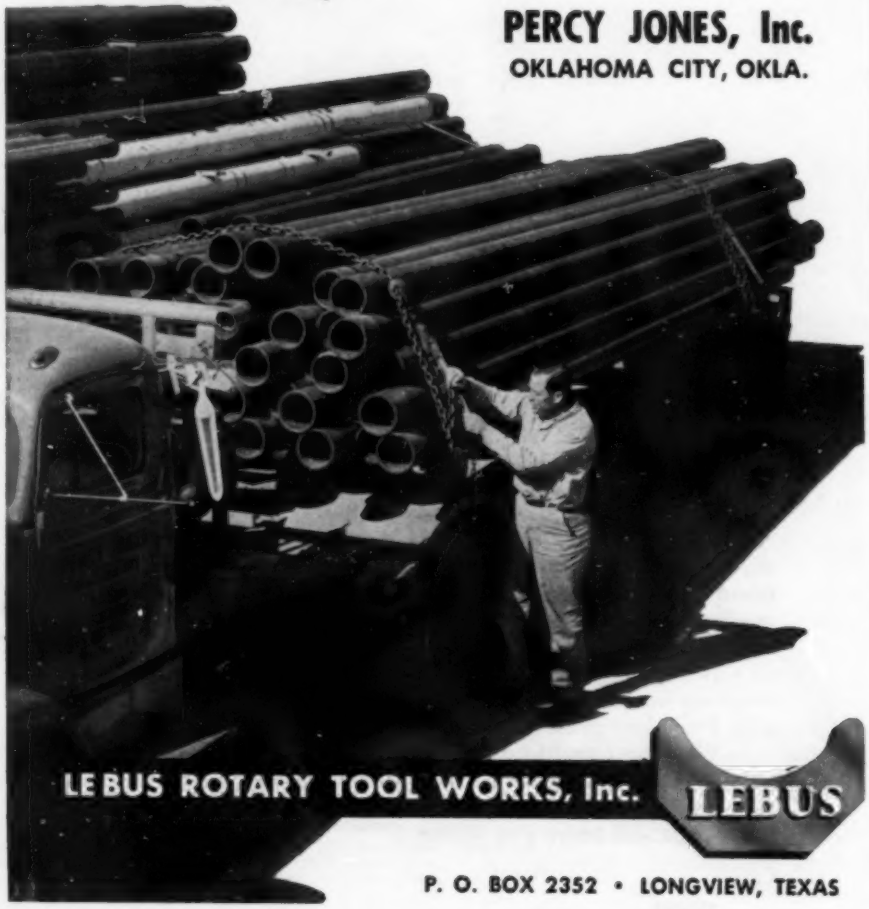
TGT's existing system will be paralleled with 221 miles of 30-inch and 26-inch pipe in Kentucky and Ohio. Approximately 376 miles of gas gathering line, ranging from 6 to 24 inches in diameter, are planned for extensions in Louisiana and Texas.

Compressor stations will be built with 4400 horsepower each near Winnsboro, La., and New Albany, Miss. An additional 2640 horsepower is planned for TGT's Kinder, La., station, and request is made for 1100 more horsepower at an authorized station near Findley Lake, N. Y.

Capacity of the 2200-mile Texas to New England system would be boosted to 1,800,000 Mcf daily with peak day capabilities of 2,180,000 Mcf. This would increase service to customers by 148,000 Mcf per day. Along with the application TGT presented 87 gas supply contracts with 57 producers in 64 Louisiana and Texas fields.

"We know all our loads will travel safely since we use only LeBus Load Binders. They are superior in every way."

PERCY JONES, Inc.
OKLAHOMA CITY, OKLA.



LEBUS ROTARY TOOL WORKS, Inc. LEBUS

P. O. BOX 2352 • LONGVIEW, TEXAS

$1.4 Billion to Be Spent For 1955 Gas Construction

The nation's gas utility and pipe line industry spent $1.1 billion during 1954 for construction of new facilities and plant expansions, and an additional $1.4 billion will be spent during 1955, the American Gas Association estimates.

The expenditure for 1954 marked the fifth successive year that $1 billion or more was spent on construction. Some pipe line projects anticipated for 1954 were deferred until this year.

Anticipated expenditure of $1.4 billion rates 1955 as second largest construction year in history. In 1951, a total of $1.46 billion was spent. The new estimate for 1955 is about $250 million higher than was estimated a year ago for this year. This increase reflects, among other projects, the start of two new lines having a total cost of $290 million. A new transmission line linking the San Juan Basin to markets in the Pacific Northwest will cost $160 million. An additional $130 million will be spent on construction of a transmission line from Louisiana to the East North Central region.

Gas industry construction expenditures have increased more than tenfold since the prewar years. Expenditures have risen from an average of $101 million each year from 1937 through 1941, to an average of $799 million in the five postwar years following 1945. Since 1950, the nation's gas facilities have been increased by the expenditure of $1 billion a year or more.

Industry estimates for 1954 and 1955 were derived from the responses of reporting companies and consideration of Federal Power Commission approvals for new companies.

Here are the AGA reported expenditures for gas utility and pipe line construction in millions of dollars:

Average, 1937-1941	$ 101
Average 1946-1950	799
Total for 1951	1462
1952	1067
1953	1350
1954 (preliminary)	1108
1955 (estimated)	1395

Construction Table on Page 97

LUBRICATE PLUG VALVES

in seconds — instead of minutes

with this timesaving combination

Yes, seconds are all it takes to lubricate plug valves, today. You'll eliminate waste, and save time and effort with this combination: Walworth High Pressure Lubricant Gun, Walworth Button-Head Fittings, and Walworth Jumbo Size Lubricant Sticks. They'll pay for themselves quickly and are adaptable to most of the lubricated plug valves that are in use today.

Walworth High Pressure Lubricant Gun. This is the only gun available today that satisfactorily handles the stick form, full-bodied lubricants needed for proper lubrication and sealing of plug valves. Easy to operate; two Jumbo Size Lubricant Sticks fill the barrel.

Walworth Button-Head Lubricant Fittings. Use them as lubricant fittings or as regular lubricant screws with standard size lubricant sticks. Just slip hose coupling onto fitting for a leakproof connection.

Walworth Jumbo Size Lubricant Sticks. Individually wrapped and packed ten to the box; clean and easy to handle . . . eliminate messy loading. Types available for most line fluids. Always use Walworth Lubricants in Walworth Lubricated Plug Valves.

Start saving today . . . call your nearby Walworth Distributor. He'll be glad to supply Walworth High Pressure Lubricant Guns, Button-Head Fittings, and the right Jumbo Size Lubricant Sticks for any lubricated plug valve service condition.

WALWORTH

Manufacturers since 1842

valves . . . pipe fittings . . . pipe wrenches

60 East 42nd Street, New York 17, N. Y.

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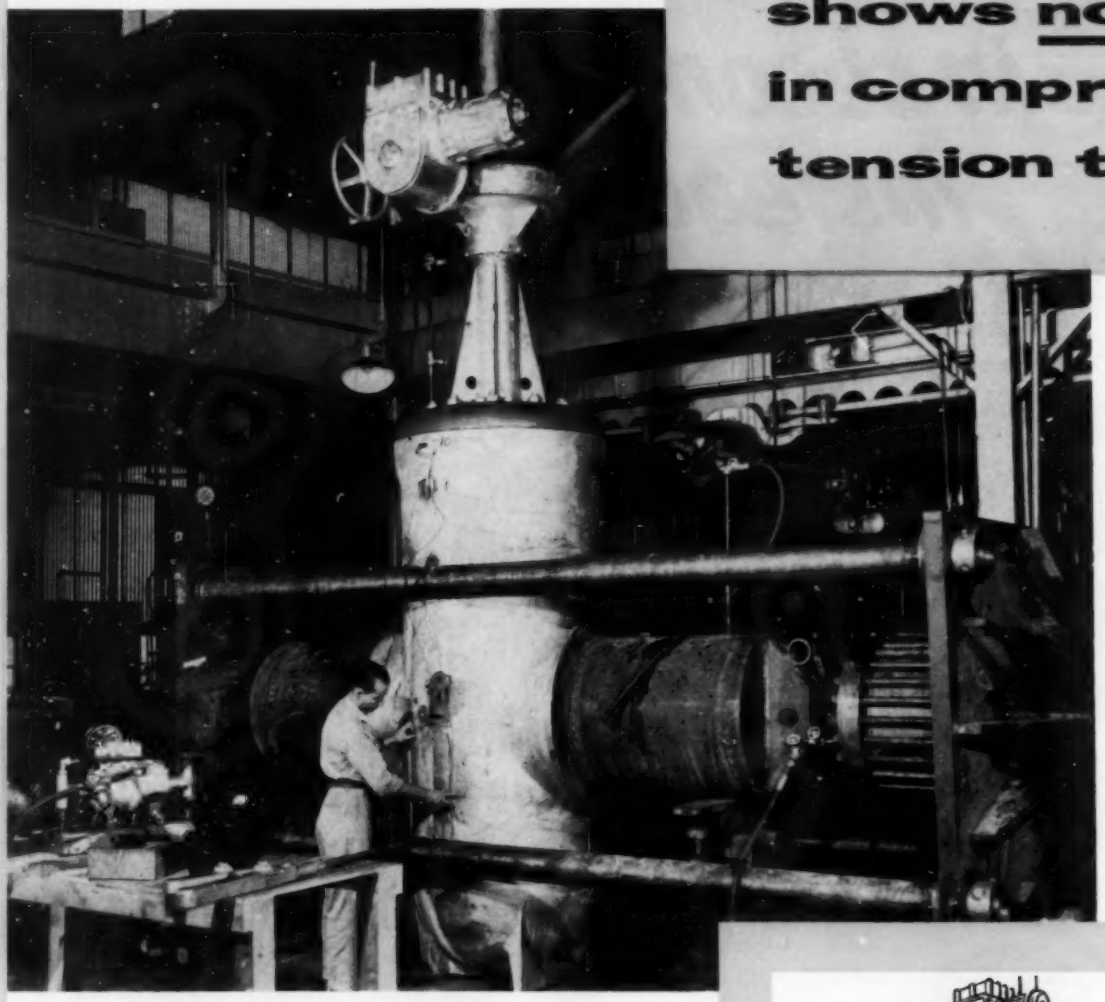
W-K-M Valve shows no leak in compression-tension tests



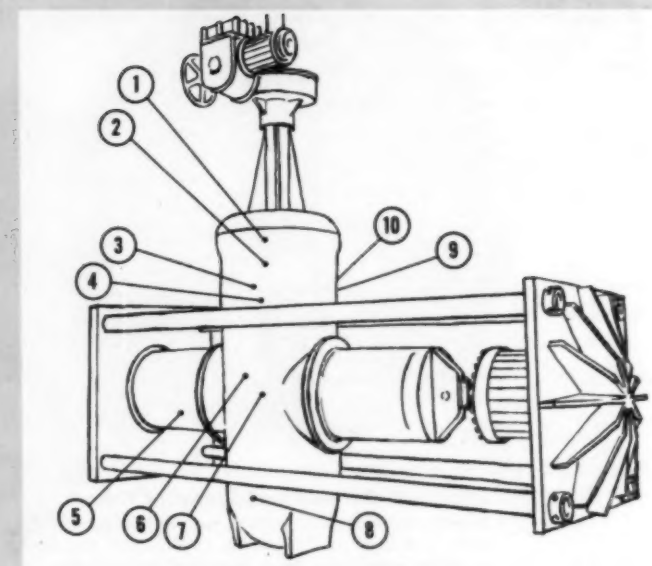
A special test was made in the W-K-M plant to determine what effect external compression and tension loads would have on seal-off and operation of a W-K-M Valve.

This test was conducted using a 30" ASA 400 p.s.i. weld-end gate valve operated by an electric motor. Ten strain gages were placed in the valve at locations shown on the diagram at right.

Using a hydraulic cylinder, an external differential tension load of 675 tons was applied to the valve while maintaining maximum working pressure against the gate.

During the tests the recorded strain-gage readings indicated no fibre stresses in excess of code allowables, indicating no appreciable body distortion. The valve did not leak and operated freely under all conditions.

W-K-M Pipeline Valves have been tested and proved in the laboratory and out on the line for more than thirty years. They offer the world's finest valve performance. Ask a W-K-M sales engineer to demonstrate a scale model valve.



The above sketch shows the placement of the strain gages used in the test.

W-K-M Valves

W-K-M MANUFACTURING COMPANY, INC.
A SUBSIDIARY OF ACF INDUSTRIES INCORPORATED

P. O. Box 2117, Houston 1, Texas
Los Angeles, California
Export Office: 45 Rockefeller Plaza, New York, N. Y.

Pipe Line Contracts Not Let

COMPANY	Length in Miles	Diameter	Type	Origin and Terminus	Estimated Cost	Status
Alabama-Tennessee Natural Gas Co.—Florence, Ala.	25	8, 12	Gas	Colbert County, Ala.	$808,450	3.7 miles authorized
American Louisiana Pipe Line Co.—666 Penobscot Bldg., Detroit, Mich.	1,289	22, 30	Gas	North Tepetate, La.—Detroit, Mich.	$130 million	Authorized
American Pipe Line Corp.—New York City (Swinerton & Walberg, Engineering)	1,425 plus 485 miles feeders & distribution lines	24, 26	Products	Beaumont, Texas area—Newark, N.J.	$170 million	Planned
Anadarko Basin Pipe Line Co.	525	24	Gas	Wise County, Texas—Texas Eastern near Memphis, Tenn.	.....	Planned
Arkansas-Louisiana Gas Co.	66	24	Gas	Arkansas, Louisiana and Texas loops	$9,245,166	Authorized
Ar-Mex Pipe Line Co.	900	8, 12, 14	Crude	Guernsey, Wyo.—Phoenix, Ariz.	$31 million	Planned
Atlantic Seaboard Corp.—Charleston, W. Va.	84	26	Gas	Parallel at various points on Cobb, W. Va. to Baltimore line.	$9.3 million	Some contracts let
Attock Oil Co.	60	....	Gas	Dhulian Field—Rawalpindi, West Pakistan.	.....	Planned
H. W. Bass & Sons, Inc.	152	4, 6	Products	Live Oak County, Texas—Corpus Christi, Texas	.....	Planned
Big Horn Pipe Line Co.—Cheyenne, Wyo.	150	8	Crude	Ash Creek, Wyo. field—Midwest, Wyo.	.....	Proposed
Buckeye Pipe Line Co.	14	10	Crude	Wayne—Detroit, Mich.	.....	Proposed
Butte Pipe Line Company-(Shell-Murphy)	450	16	Crude	Williston Basin—Guernsey and Fort Laramie, Wyo.	$19 million	Proposed
California-Oregon Pipe Line System	103	6	Crude	Crescent City, Calif.—Medford, Ore.	$2 million	Planned
Carolina Natural Gas Corp.—701 Wilder Bldg., Charlotte, N.C.	185	2, 12	Gas	North and South Carolina	.....	Proposed
Central Hudson Gas & Electric Co.	48	12	Gas	Albany—Kingston, N.Y.	.....	Applied to FPC
Cities Service Gas Co.—1st National Bank Bldg., Oklahoma City, Okla.	33	20, 26	Gas	To replace lines in Kansas and Missouri	$1,860,000	Authorized
	13	....	Gas	Labette County, Kansas	$285,000	Authorized
	15.5	16	Gas	Carter County—Garvin County, Okla.	$541,050	Authorized
	11.5	2, 4, 8	Gas	Johnson and Cass Counties, Mo.	$140,000	Before FPC
	93	26	Gas	Blackwell, Okla.—Independence, Kan., plus 145 miles of gathering lines	$8.4 million	Before FPC
City of Dalton, Ga.	39	8	Gas	To connect with Southern Natural Gas Co. line	$2,940,000	Proposed
Clinchfield Coal Corp.—Dante, Va.	16	12	Gas	Dickenson County, Va.—Osborne Gap, Ky.	$785,000	Before FPC
Coastal Transmission Corp.—Houston, Texas	500	30	Gas	McAllen, Texas—Louisiana connection, Houston, Texas Gas.	$110 million	Considered
Coast Counties Gas & Electric Co.—369 Pine St., San Francisco	40	3, 4, 8	Gas	Coast and Valley region, Calif.	.....	Planned
Colorado Interstate Gas Co.	365	22	Gas	Rock Springs, Wyo.—Denver, Colo.	$23,299,000	Some contracts let
	115	4, 6, 8	Gas	Denver—Julesburg Basin—Basin Cities	.....	Before FPC
Colorado Western Pipe Line Co.—Dallas	708	....	Gas	Southeastern Colorado fields—Denver, plus laterals	$30 million	Planned
	328	16, 18	Gas	LaPlata County—Pueblo, Colorado Springs and Denver	$21,600,000	Authorized
Compania del Oleoducto Buenaventura—Cali, Colombia, S.A.	90	....	Products	Buenaventura—Cali, Colombia, S.A.	$4 million	Planned
Consolidated Gathering Systems, Ltd.	198	....	Crude	Sturgeon Field—Edmonton.	.....	Planned
Consolidated Natural Gas Corp.—New York	112	....	Gas	In Ohio—Plus other smaller lines	$6 million	Planned
Dixie Pipe Line Co.	20	8	Gas	Gwinville Field, Miss.—Transcontinental Gas line	$425,000	Proposed
El Paso Natural Gas Co.—El Paso, Tex.	32.5	10	Gas	Reagan and Upton counties, Texas	$799,000	Authorized
	74	....	Gas	Texas, New Mexico and Arizona	$13,800,000	Authorized
	370	....	Gas	Mountain Home, Idaho—Reno, Nev.	$35 million	Proposed
	500	34	Gas	Parallel from San Juan Basin to Topock, Ariz.	.....	Planned
	....	30	Gas	Pendleton, Ore.—Calif.	.....	Considered
Empresa Nacional del Petroleo	80	6	Products	Concon—Santiago, Chile	.....	Planned
Governments of Southern Rhodesia and Portuguese South Africa	200	....	Products	Beria, Portuguese Mozambique—Umtalia, Southern Rhodesia	.....	Considered
Hope Natural Gas Co.—445 W. Main St., Clarksburg, W. Va.	33	8, 10, 12	Gas	Wyoming County, W. Va.—Buchanan County, Va.	.....	Proposed
Houston Texas Gas & Oil Co.—4604 Main St., Houston	1042	18, 24, 36	Gas	Louisiana—Miami, Fla.	$110 million	Considered
Idaho Natural Gas Co.—Goodland, Kansas	....	....	Gas	Pacific Northwest line—points in Southern Idaho	.....	Proposed
International Pipe Line Co.. Inc.—227 N. Colfax Ave., Minneapolis, Minn.	132	8	Products	Wrenshall, Minn.—Minneapolis Bulk Terminal	$4,250,000	Planned
Iraq Petroleum Co.	75	24	Crude	Homs, Syria to Tripoli	.....	Proposed
Kansas-Nebraska Natural Gas Co.—Phillipsburg, Kansas	283	6-12	Gas	Central and northeast Nebraska	$4,096,890	Some contracts let
Kentucky-West Virginia Gas Co.	32	12	Gas	Service line to Maytown, Ky.	.....	Before FPC
Keystone Pipe Line Corp., Philadelphia	48	8	Products	Boot—Fullerton, Pa.	$1,875,000	Approved
Lateral Gas Pipe Line Co.—Cedar Rapids, Iowa	27	4	Gas	Grant—Clarinda, Iowa	$267,000	Proposed
Lone Star Gas Co.—Dallas	230	22, 26	Gas	Cotton County, Okla.—Fritch, Texas	$18.7 million	Before FPC
Malco Pipe Line, Inc.	91	6	Products	Prewitt, N.M.—Albuquerque	$1,250,000	Planned
Mayflower Pipe Line Co.-(Pine Tree Natural Gas Co.) —70 Pine St., New York, N.Y.	200	....	Products	New Jersey refining area—New England	.....	Planned
Michigan Consolidated Gas Co.—415 Clifford, Detroit	25.5	12	Gas	Sparta—Muskegon, Mich.	$13 million	Proposed
Michigan Gas Storage Co.	36	16	Gas	Mount Pleasant Junction—Milwaukee, Mich.	$2.6 million	Before FPC
Michigan-Wisconsin Pipe Line Co.—500 Griswold, Detroit	252	4-24	Gas	Wisconsin	$11 million	Proposed
Missouri Central Gas Co.	25	6	Gas	Moberly—Macon, Mo.	.....	Proposed
Missouri Public Service Co.—Warrensburg, Mo.	136.4	8-10	Gas	New Franklin, Mo.—Grundy County, plus laterals	$5 million	Proposed
Montana-Dakota Utilities Co —Minneapolis	56	2, 4, 6	Gas	Hettinger and Stark counties, N.D.	$728,854	Authorized
	30	16	Gas	Service lines and compressor facilities at various locations	$1.9 million	Before FPC
Moore-Stoner Co.	200	6	Products	Glendive, Mont.—Minot, N.D.	$2,000,000	Planned
NATO	1920	4-10	Products	To serve military bases in Western Europe	.....	Foster-Wheeler Prime Contractors
Natural Gas Pipe Line Co. of America—20 N. Wacker Dr., Chicago	350	20, 26	Gas	Wise County, Texas—Fritch, Texas	$28.5 million	Before FPC
Natural Gas Producers, Inc.—Colorado Springs	61.8	12	Gas	Yenter Pool—Denver	$1,374,000	Planned
	49	10	Gas	Denver-Julesburg Basin—Fort Morgan, Brush and Denver	.....	Planned
Natural Gas Storage Co. of Illinois—Chicago	35	36	Gas	Delivery from Herscher, Ill. storage field.	$7 million	Before FPC
Nebraska Pipe Line Co.	220	6	Products	Cheyenne, Wyo.—North Platte, Neb.	$4 million	ODM certificate granted
Nevada Natural Gas Co.	....	....	Gas	Various loops along Needles, Calif—La Vegas, Nev. line	$2.5 million	Planned
New River Gas Co.	50	....	Gas	Summers-Monroe Counties, W. Va. and Narrows and Dublin, W. Va.	.....	Planned
New York State Natural Gas Corp.	21	20	Gas	Pertageville—Craigs Connection Loop	.....	Before FPC
NNCW Pipe Line Co.—Dallas, Texas	127	8, 10	Crude	Clareton Field—Casper, Wyo.	$3.6 million	Planned
Northern Natural Gas Co.—2223 Dodge St., Omaha	167	24	Gas	Farmington, Minn. to Duluth, Minn. and Superior, Wis.	$12 million	Before FPC
	329	2, 12	Gas	Sioux Falls to Aberdeen. S.D.	$6,661,100	Proposed
	....	....	Gas	To interconnect with Natural Gas Pipe Line	$244,000	Planned
	403	24, 30	Gas	Emerson, Manitoba, Canada—Farmington, Minn.	$32,813,000	Before FPC
	28.4	30	Gas	Test lines to underground storage near Redfield, Iowa	$4.8 million	Before FPC
Northwestern Utilities, Ltd.—10124-104th St., Edmonton, Alberta, Canada	42	12	Gas	Bonnie Glen—Edmonton, Alberta	$1.4 million	Proposed
Ohio Fuel Gas Co.	18.9	16	Gas	Loop present lines	.....	Before FPC
Pacific Gas & Electric Co.	135	34	Gas	Topock, Ariz.—Milpitas, Calif.	.....	Planned
Pacific Northwest Pipe Line Corp.—M & M Bldg., Houston	1466 plus 443	Various	Gas	San Juan Basin—Pacific Northwestern states	$163 million	Authorized—Contracts let for 665 miles
Panhandle Eastern Pipe Line Co.	58	16	Gas	Springfield—Peoria—Illinois Loop	.....	Before FPC
Pawnee Pipe Line Co.	15	8	Crude	Northeast Colorado Sector—Denver-Julesburg, Basin	.....	Planned
Permian Basin Pipe Line Co.	11	6	Gas	Lea County, N.M.	.....	Before FPC
Petroargentina	370	16	Crude	Newguen—Bahia Blanca, Argentina	$40 million	Planned
Petroleos Mexicanos—Ave. Juarez, 94, Mexico City	440	20	Gas	Brazil—Tampico—Posa Rica, Mexico	.....	Planned
	260	6, 8	Products	Lagos, Mexico—Guadalajara, Aguascalientes and Salamanca	.....	Planned
	145	12	Crude	18 de Marso Field—Monterrey, Mexico	.....	Considered
	72	12	Crude	Posa Rica—Atzacapotzalco, Mexico	.....	Proposed

119 Reasons why ARMCO Line Pipe Saves Money

This table shows the sizes (O.D. and wall thicknesses) of Armco Welded Steel Pipe for oil and gas industry applications. With this range of 119 sizes—one of the widest selections available today—it's easy to match pipe needs *exactly*. You avoid paying for more metal than you need and make important savings.

Another money-saving advantage with Armco Welded Steel Pipe is that you can order *uniform* lengths up to 50 feet. This means you have fewer joints to make and that you know in advance how many lengths and joints will be required for any installation. Costs are held down.

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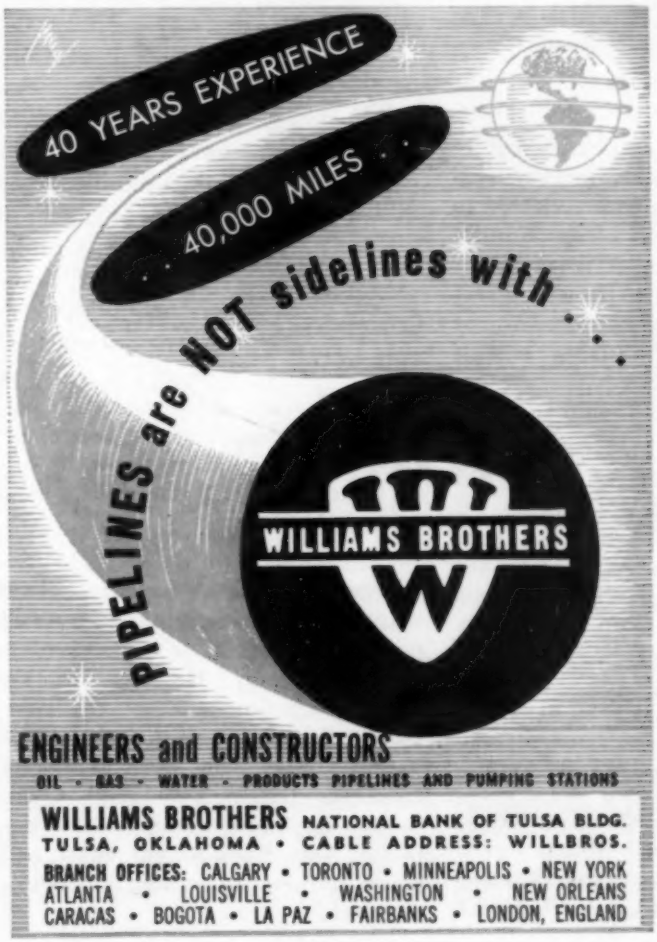
Pipe Line Contracts Not Let—(Continued)

COMPANY	Length in Miles	Diameter	Type	Origin and Terminus	Estimated Cost	Status
Phillips Petroleum Co.—Bartlesville	54	6	Products	Goldsmith—Borger, Texas	.....	Planned
S. & M. Pipe Line Co., Ltd.	100	8, 10	Crude	Midale, Forbisher, Steelman, Lampman, Alida, and Nottingham, Sask. to Crome, Manitoba	.....	Proposed
Salt Lake Pipe Line Co.	....	....	Products	El Paso, Texas—Albuquerque, N.M.	$4 million	Planned
Santos Jundiai Railway Co.—Brazil	....	8, 14, 22	Crude & Products	Expansion of Santos—Sao Paulo system	$5 million	Planned
Shell Pipe Line Corp.	22	6	Crude	Ropes Field, Texas	.....	Proposed
	15	4	Crude	Brahaney Field, Texas	.....	Proposed
Shenandoah Gas Co.—Lynchburg, Va.	40	3, 4, 8	Gas	Virginia Gas Transmission Co. System—Virginia and West Virginia towns	$1,470,000	Authorized
Sioux Oil Co.	50	8	Products	Newcastle, Wyo.—Rapid City, S.D.	$1 million	Planned
Southern California Gas Co. and Southern Counties Gas Co.	....	30	Gas	Topock, Ariz.—Los Angeles	$31 million	Planned
Southern Counties Gas Co.	31.5	30	Gas	Cactus City—Desert City, Calif.	$2.5 million	Proposed
Southern Pacific Pipe Lines, Inc., San Francisco	800	8–16	Products	Los Angeles—El Paso	$30 million	Contracts let for 330 miles
Standard Pipe Line Co.	350	16	Crude	Glendive, Mont.—Guernsey, Wyo.	.....	Before ODM
	330	16	Crude	Wink, Texas—Albuquerque, N.M.	.....	Before ODM
Sturgeon Pipe Line, Ltd.	100	12	.....	Sturgeon Lake Field—Trans-Mountain system	$6,500,000	Planned
Sunflower Pipe Line Co.—Tulsa, Okla.	265	3–6	Products	Kearny, Grant and Haskel Counties, Kansas—Wichita, Kansas	$3.5 million	Authorized
Tennessee Gas Transmission Co.—Box 2511, Houston	370	30	Gas	Agua Dulce, Texas—Kinder, La.	$35.4 million	Authorized
	221	26, 30	Gas	Loops in Kentucky and Ohio plus 376 miles of gathering line in Texas and Louisiana	$56 million	Before FPC
Texas Eastern Transmission Corp.—Texas Eastern Bldg., Shreveport, La.	382	24	Gas	Beaumont, Texas—Kosciusko, Miss. plus 99 miles lesser diameter	$71.8 million	Some contracts let
Texas Eastern Transmission Corp. and Texas Eastern, Penn-Jersey Corp.	11	....	Gas	Loops in Philadelphia area plus compressor facilities	$2.4 million	Before FPC
Texas Gas Corp—Winnie, Texas	40	4–12	Gas	Orange County, Texas—Cameron Parish, La.	$3.5 million	Authorized
Texas Gas Transmission Corp.	190	20	Gas	East Lake Palourde, La.—main trans. line	$20 million	Before FPC
Trans-Canada Pipe Line, Ltd.—Calgary, Alberta	2240	30, 36	Gas	Alberta—Eastern Canada	$297 million	Approved
Transcontinental Gas Pipe Line Corp.—3100 Travis St., Houston	....	....	Gas	Connecting facilities with Texas Eastern Penn-Jersey in Pennsylvania and New Jersey	$131,628	Authorized
Trans-Prairie Pipelines, Ltd.	....	....	Crude	Gathering lines in Midale and Forbisher oil fields, Canada	.....	Proposed
Triangle Pipe Line Co.	560	12	Products	Arkansas City, Ark.—Covington, Ky.	$24.5 million	Proposed
Trunkline Gas Co.	24	....	Gas	Loop present line	$17.7 million	Before FPC
Union Gas Co. of Canada, Ltd.—Chatham, Ontario	180	24	Gas	Dawn Gas Field to Lamberton County to deliver gas to Dominion Gas Co.	.....	Planned
United Gas Pipe Line Co.	63	16, 20	Gas	Various location in Miss., Ala. and Florida	$8.3 million	Before FPC
U. S. Dept. of Defense	97	....	Crude	Elk Hills Naval Reserve—Los Angeles	$8 million	Considered
U. S. Navy	600	10	Products	Rota—Zaragoza, Spain	$40 million	Planned
	450	8	Gas	Gubik Field—Fairbanks, Alaska	$20 million	Planned
Utah Natural Gas Co.	40	16	Gas	Orem—Salt Lake City, Utah	.....	Planned
Virginia Natural Gas Co.	153	....	Gas	Buckingham—Richmond and Portsmouth, Va.	.....	Planned
West Coast Pipe Line Co.—Mercantile Bank Bldg., Dallas	960	24, 26	Crude	Wink, Texas—Norwalk, Calif.	$106 million	Planned
Westcoast Transmission Company, Ltd.	650	30	Gas	Peace River Fields–Sumas, Wash.	$140 million	Authorized
	....	30	Gas	Peace River Fields—Okanagan Valley	.....	Planned
	....	....	Gas	Alberta—Quebec	.....	Considered
Wilcox Trend Gathering System, Inc.	16	16	Gas	Loop near Provident, Texas	$2.2 million	Before FPC
Winnipeg and Central Gas Co.	450	4–8	Products	Tioga, N.D.—Winnipeg, Canada	$30 million	Planned
Wyoming Gas Products Corp.	....	....	Gas	Gathering system in Weston County, Wyo. to feed gasoline plant	.....	Planned
Yacimientos Petroliferos Fiscales Bolivianos	170	4	Crude	Bermejo—Tupinza, Bolivia	.....	Planned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Pipe Line Men

IN THE NEWS

Chester S. Stackpole, general sales manager, Heating and Cooling division, Union Asbestos & Rubber Company, has been appointed managing director of the **American Gas Association.** He joined the Association June 1, succeeding H. Carl Wolf, who resigned earlier this year.

C. S. Stackpole

Stackpole previously has been vice president of the Eureka Williams Corporation, and before that, vice president and general sales manager, Airtemp division, Chrysler Corporation and vice president, Airtemp Construction Corporation. He has been with Consolidated Gas Electric Light and Power Company of Baltimore and Stone and Webster, Inc.

Stackpole has been chairman of the A.G.A. House Heating Committee and vice president of the A.G.A. while serving as chairman of the Residential Gas Section.

•

A. L. Vaughan, superintendent of **Northern Natural Gas Company** compressor stations, has been reelected to the board of directors of the Natural Gasoline Association of America for a term of three years. He is in direct supervision of compressor facilities of Northern and its subsidiary, Permian Basin Pipeline Company.

•

The promotion of **Harry McLeod** to superintendent of the Crude Oil Pipeline division, **Arkansas Fuel Oil Corporation,** has been announced. Crude oil pipe line operations are carried on through the Arkansas Pipeline Corporation, a wholly owned subsidiary of Arkansas Fuel Oil Corporation.

McLeod has served as assistant superintendent of crude oil pipe line operations since 1951. His employment with the company began November 26, 1929, and he has served in various capacities in the Pipeline division since that time.

Two new directors have been elected to the Board of **Humble Pipe Line Company.** They are **William S. Spangler,** general superintendent, and **Charles E. Shaver,** attorney.

Spangler joined Humble Pipe Line in 1933 and worked in the company's East Texas division until 1935 when he transferred to the Engineering department in Houston. In 1945 he was made assistant division superintendent of the Southern division and in December, 1951, was named general superintendent.

Shaver joined Humble's Exploration department as a land man and in 1941 transferred to the company's Law department. Until 1952 he did law work for the Exploration and Production departments. Since 1952 he has handled legal matters for the pipe line company.

•

C. C. Combs has been elected a vice president of **Shell Pipe Line Corporation.** Since 1950 he has been on various special assignments, including three years as controller of Shell Oil Company of Canada, Ltd.

C. C. Combs

Joining the Shell organization in 1923 as a service station attendent in California, Combs has been an auditor, assistant corporate secretary of Shell Oil, assistant treasurer, and assistant treasurer and assistant controller in the San Francisco office. As vice president, he will be located at Shell Pipe Line's head office in Houston.

•

Kenneth C. Cribley has been named manager of products pipe lines and products terminals for **Champlin Refining Company.** He was formerly general superintendent of the company's Stratton pipe line in South Texas. Cribley will be in charge of Champlin terminals in Enid, Oklahoma City, Hutchinson, Kansas, Superior, Neb., Rock Rapids, Iowa, and a new terminal to be built in Columbus, Neb.

Robert E. Chrone

Evan F. Walker

Dale S. Cooper and Associates, consulting engineers, recently moved into their new office building in Houston. The firm has been doing pipe line engineering for two years. **Robert E. Chrone, Evan F. Walker** and **Dale S. Cooper** head the company's various departments. Walker, head of the engineering design section as related to pipelining, has been in the industry for 35 years.

Dale S. Cooper

•

Harold S. Walker, Jr., formerly of Lit Bros., Philadelphia, has been appointed secretary of the General Management section of the American Gas Association. He succeeds Harrington A. Rose, who recently resigned.

From 1949 to 1953 Walker served as instructor and assistant professor at West Point. He joined Lit Bros. division, City Stores, Inc., in 1954.

•

Warren L. Baker, editorial director of WORLD OIL, and for many years secretary of The Gulf Publishing Company, was elected vice president of the company at a directors meeting in May. **L. J. Logan,** exploration editor of WORLD OIL, was elected secretary of The Gulf Publishing Company. Both men have been with the company for more than 25 years.

Other officers of the company were reelected. They are **Ray L. Dudley,** president; **A. L. Burns,** executive vice president; **Tom W. Nelson,** vice president.

•

Ehrhart & Arthur, Inc., engineers and constructors of Los Angeles, have announced the election of **Frank Sesler** to the position of vice president. Sesler will continue as manager of the company's Oakland, Calif., branch office.

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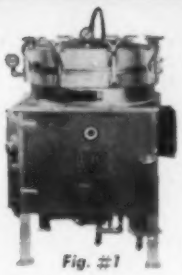

Fig. #1

OIL RECLAIMER

For continuous oil purification in range of 2-100 gph. Removes all solids, acids and volatile contaminants.

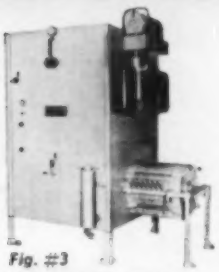

Fig. #3

PURIFIER-RE-REFINER

For all purification in batches of from 6 to 100 gallons. Removes all solids, acids and volatile contaminants.

Fig. #2

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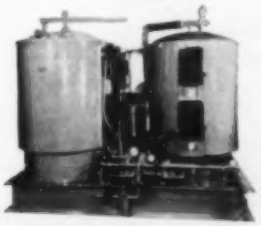

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- Locomotives
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For more data on advertised products, use Readers' Service Cards, last page.

Shell Pipe Line Corporation has appointed **J. K. Alfred** general superintendent of construction for the crude oil pipe line to be built in eastern Montana and Wyoming by that company as agents for the Butte Pipe Line Company.

Butte will be owned jointly by Shell Oil Company, The Murphy Corporation and Placid Oil Company.

Alfred, a veteran of nearly 20 years with Shell Pipe Line, will supervise all construction activities of the line, pump stations and related facilities.

J. W. LaBoon has been named manager of Shell Oil Communications department with headquarters in Houston. He succeeds F. W. Littell, whose retirement was announced recently.

LaBoon comes to Houston from Tulsa, where he has been serving as area communications superintendent for the past eight years. He has had 26 years with Shell Pipe Line, starting his career in St. Louis in 1928.

R. V. Herman has been appointed to fill LaBoon's position in Tulsa.

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W. M. Elmer

John Kirtley

W. L. Stanton

V. W. Meythaler

The board of directors of **Texas Gas Transmission Corporation** have elected two new vice presidents and a treasurer and appointed **W. M. Elmer** senior vice president in charge of financing, sales, gas supply, production and Federal Power Commission regulation. Elmer formerly was vice president and treasurer.

John Kirtley, director of public and employe relations, was elected vice president in charge of those departments, and **W. L. Stanton,** manager of the company's Gas Supply department, was named vice president in charge of Gas Supply.

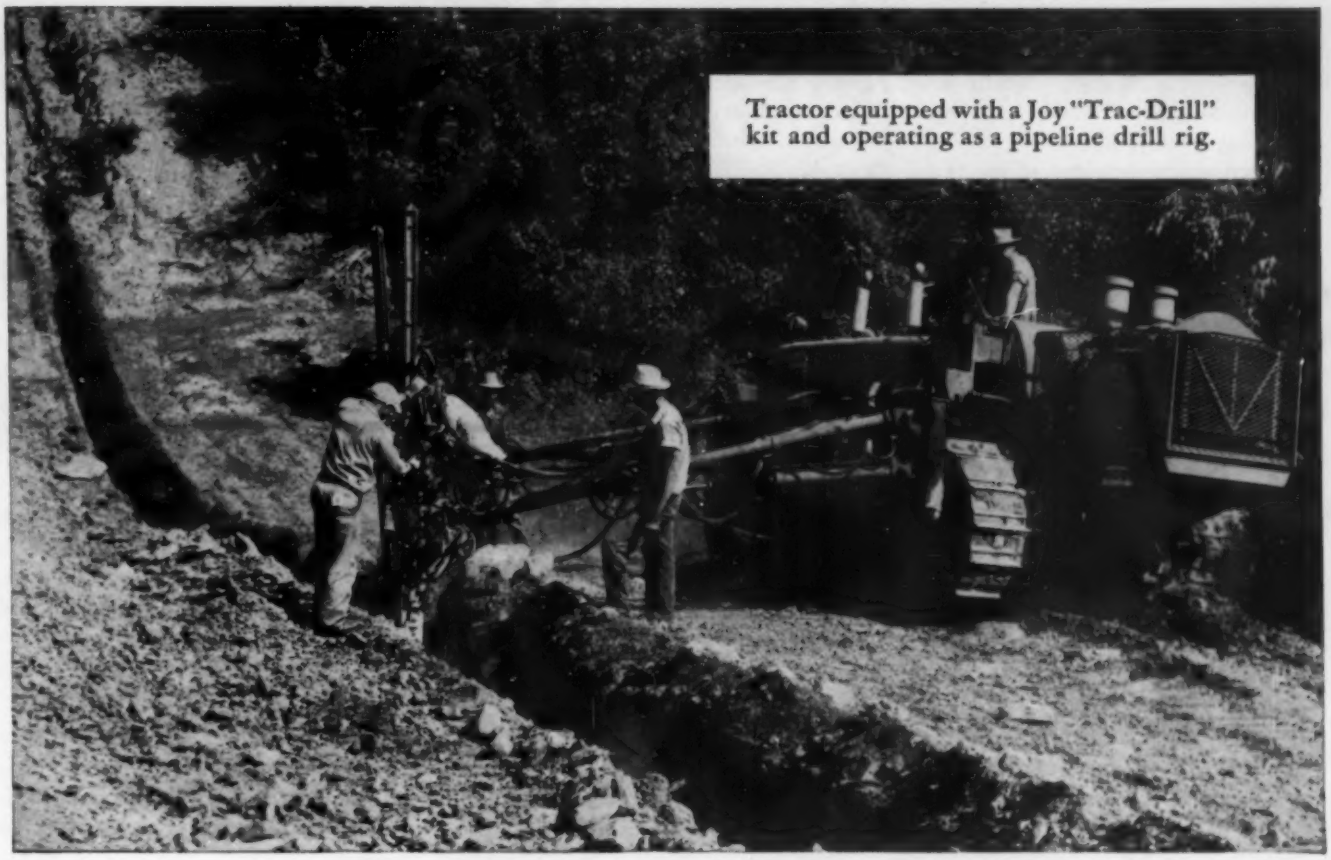
V. W. Meythaler, formerly assistant treasurer, was elected treasurer to succeed Elmer. **R. W. Brandon,** manager of the Internal Audit department, was elected assistant treasurer.

Standard Oil Company (Indiana) has announced four products pipe line appointments in the Supply and Transportation department.

A. F. Smith has been named division master mechanic in the Chicago division, and **Dwight Browning,** replacing him, has been appointed district superintendent of the Rochelle, Ill., district.

D. A. Gayer has been named terminal superintendent of the Twin Cities, Minn., terminal; replacing Browning. **L. D. Stratton** succeeds Gayer as terminal superintendent at Ottumwa, Iowa.

Smith joined Standard Oil in 1947, was made district superintendent at Minneapolis in 1950, and district



Tractor equipped with a Joy "Trac-Drill" kit and operating as a pipeline drill rig.

THE JOY "TRAC-DRILL"

A PIPELINER RIG THAT GETS THERE FASTER TO SAVE YOU TIME AND MONEY

This PIPELINER, the Joy "Trac-Drill," is a packaged drill-and-compressor unit for pipeline drilling that is easily assembled on *your* tractor. The assembly kit consists of drill and compressor "packages" and instructions for assembly. Drill package includes Joy Silver Streak Drills, Hydro Drill Jibs, mounting bracket, hydraulic pump and other accessories. Compressor package includes a Joy WL-80 compressor, mounting bracket, air receivers, etc.

Two drills are mounted on dual, hydraulically-actuated Joy Hydro Drill Jibs. With these jibs, the drills are quickly and easily positioned and are held absolutely stationary during drilling. This is a real "Pipeliner" rig . . . the double drill arrangement permits the drilling of several holes from each tractor setup.

The Joy "Trac-Drill" moves and operates as one self-contained unit. It moves in on those tough spots in the spread faster because there is no need to tow a separate source of compressed air into the area.

Consult a Joy Engineer TODAY for details on how you may equip your tractor for pipeline drilling. ● ***Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.*** In Canada: *Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*

Consult a Joy Engineer

ABOUT Stationary and Portable Compressors . . . Rock Drills . . . Rock Bits . . . Electrical Connectors . . . Portable Lighting Lines.

WAD C-5363

JOY

CONSTRUCTION EQUIPMENT MANUFACTURERS FOR OVER HALF A CENTURY

superintendent of the Rochelle district in 1954.

Browning, with the company since 1937, became terminal superintendent at Spring Valley, Minn., in 1947. He has been superintendent of the Twin Cities terminal since 1953.

Gayer joined the company in 1943. In 1949 he became superintendent of Standard's river terminal at Cape Girardau, Mo., and, in 1953, terminal superintendent at Ottumwa.

Stratton, with Standard since 1928, has been assistant superintendent of the Des Moines terminal since 1947.

G. Elmore Mays, assistant chief engineer, Interstate Oil Pipe Line Company, has been appointed administrative assistant to J. J. Winterbottom, transportation co-ordinator, and Loren K. Kahle, deputy transportation co-ordinator, **Standard Oil Company (New Jersey).**

Mays joined Interstate in 1943 and served in Oklahoma, Illinois, Mississippi and Louisiana. For two years, 1949-1950, he worked with the pipe line advisor for Standard Oil of New Jersey in New York. He returned to Interstate in 1950.

J. E. Green, assistant Mid-Continent area manager of **Shell Pipe Line Corporation,** who was seriously injured in a plane crash March 20, is expected to return to Springfield, Ill., for further treatment from his home in Cushing late this month. In the accident, which occurred north of Springfield, Green was thrown from the plane and received serious head injuries and multiple leg fractures.

J. E. Green

Green began his career with Shell in 1940 and has since been located in St. Louis, Colorado City, Kilgore, Cushing, Houston, and Healdton. He also spent a short time in Venezuela on a special assignment in 1952. He moved to Cushing in 1954.

•

Elevation of **James B. Black,** president of **Pacific Gas and Electric Company** since 1935, to chairman of the board of directors, and appointments of **Norman R. Sutherland** as president and general manager and **Robert H. Gerdes** as executive vice president and general counsel have been announced.

Sutherland was formerly vice president and general manager, and Gerdes, vice president and general counsel.

Black has completed 43 years' service with PG&E and a predecessor company. He has been a director 25 years and president 20 years. He began his career as a service inspector in San Francisco for the Great Western Power Company.

Sutherland began his career with PG&E 42 years ago as a gas lamp lighter after school hours. In 1923 he was made commercial manager of the company, and, in 1945, vice president in charge of sales. He became vice president and general manager in 1950 and was elected a director in 1952.

Gerdes was first employed by the company as assistant to the general counsel in 1929. He returned to private law practice in 1935, but in 1944 rejoined the company's legal staff as assistant general counsel. He became general counsel in 1945 and was elected vice president and general counsel and a director in 1953.

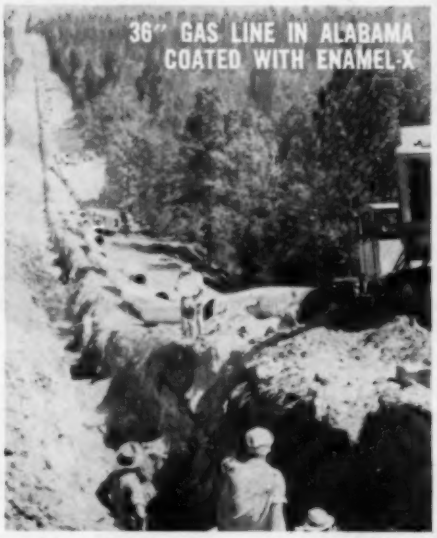
Enamel-X
PIPE ENAMELS & PRIMERS

PROVEN SUPERIORITY

CHECK THESE FACTS:

1. Having a lower specific gravity than most other enamels, Enamel-X gives greater coverage of the same thickness for the same weight of material.
2. Enamel-X enamel has greater resiliency (ability to return to the original position after stress) than most other enamels which during pressure loading and unloading on lines provides resistance to damage such as cracking or disbonding of coating.
3. Due to absence of plastic flow, Enamel-X has less wastage during storage and is easier to handle after storage.
4. Free from objectionable fumes during application, Enamel-X reduces the likelihood of accidents and frequent labor turnover.

These facts have been proven time after time through the application of Enamel-X Pipe enamels in many varied installations and under the most rugged conditions.



For further information write for your FREE copy of the Enamel-X bulletin TODAY!

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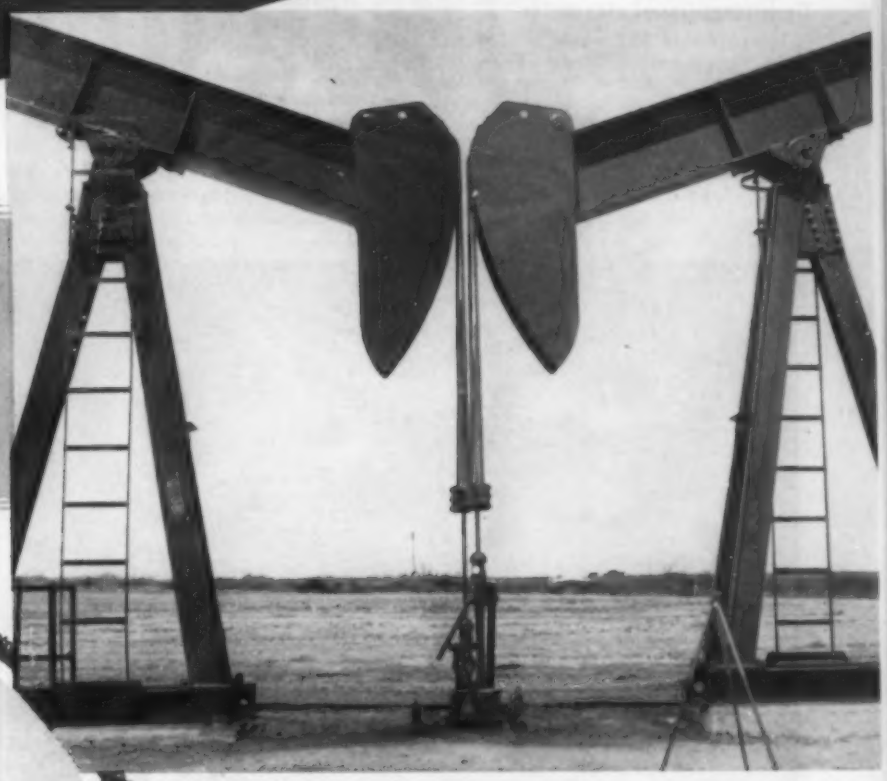
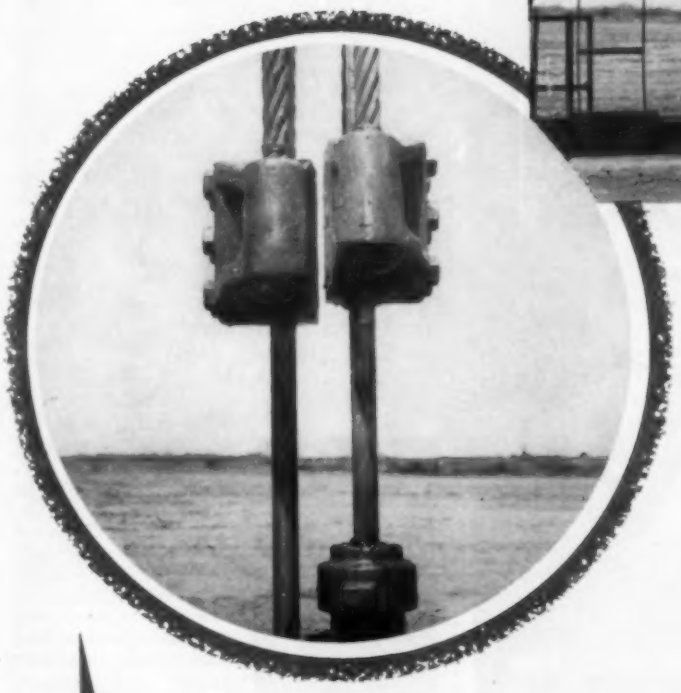
The Enamelex Corp.
OF TEXAS
1220 POLK • HOUSTON, TEXAS

two LUFKINS get their HEADS together

to solve another "Knotty" dual completion pumping problem





New LUFKIN "Flush Type" hanger bar with built-in polished rod clamp makes possible the operation of two strings on as close as 3¾ inch centers.

◀ TWO ZONES PRODUCED INDEPENDENTLY IN ONE WELL BY THE USE OF TWO PUMPS WITH SEPARATE STRINGS OF TUBING AND RODS.

Lufkin **FOUNDRY & MACHINE COMPANY**

LUFKIN, TEXAS

Branch Sales and Service: Houston • Dallas • New York • Tulsa • Los Angeles • Seminole • Oklahoma City • Corpus Christi • Odessa
Kilgore • Wichita Falls • Casper, Wyoming • Great Bend, Kansas • Effingham, Illinois • Sterling, Colorado
Lafayette, Louisiana • Bakersfield, California • El Dorado, Arkansas

Lufkin equipment in Canada is handled by THE LUFKIN MACHINE CO., LTD., 14321 108th Avenue EDMONTON ALBERTA CANADA

What's Happening

AMONG SERVICE AND SUPPLY MEN

Felber and Torgersen Promoted By International Harvester

International Harvester has announced the appointment of Menno Felber, formerly manager of the company's Tractor Works in Chicago, as assistant manager of manufacturing, Industrial Power division. He succeeds R. E. Bloye who has been made manager of manufacturing of the company's French subsidiary.

Felber served as manager of Harvester's Tractor Works for six years. Prior to that assignment, he served at the Melrose Park and Milwaukee Works in a similar capacity.

At the same time the company announced the appointment of Henry A. Torgersen as manager of Tractor Works, succeeding Felber. Torgersen comes to Chicago from Louisville, Ky., where he was assistant manager of Harvester's Louisville tractor manufacturing plant.

when the moon has pipelines they'll be cleaned with . . .
WmSON WCK-12 PIGS
They're "out of this world" already — according to pipeliners who use them.
THEY'RE NOTED FOR:
• SIMPLICITY OF DESIGN
• DEPENDABILITY OF PERFORMANCE
in all kinds of lines 6" through 14" sizes
T.D. Williamson, Inc.
THE PIG WITH THE POKE
CLEANS PIPE LINES
P. O. BOX 4038
TULSA 9, OKLAHOMA

REPRESENTATIVES (with their feet firmly on the earth)

Houston • Pittsburgh • Kenilworth, N. J. • Amarillo • Casper • Provo, Utah • Joliet, Illinois
Los Angeles • San Francisco • Bartlesville, Okla. • Edmonton • London, Ontario • Calgary
Buenos Aires • Durban, Natal, South Africa

Le Roi Division Names Graf Sales Promotion Manager

Glenn W. Graf has been named manager, sales promotion of Le Roi division Westinghouse Air Brake Company. He succeeds Richard H. Koehler who was recently appointed director of advertising and publicity and is now working out of company headquarters in Pittsburgh.

Glenn W. Graf

Graf has been in the sales promotion department of the Milwaukee division for more than two years. Prior to joining Le Roi he spent two years in an editorial position with Bucyrus-Erie Company. His background also includes newspaper and radio work in western Pennsylvania.

•

Pacific Coast Borax Co. Opens Kansas City Office

It has been announced by Pacific Coast Borax Co. that they have opened a new district office in Kansas City, Mo., at 4010 Washington Street. This office will be a district office for the Package, Agricultural Sales and Industrial Sales divisions of the company.

Howard B. Cain is Package department sales manager for the Kansas City District, and F. M. Dosch, assisted by J. G. Neckerman, will be in charge of the Agricultural division. Jack Loesel is taking charge of Industrial Sales in the area.

•

Ford Joins Tod Pazdral As Company Sales Engineer

F. A. (Jim) Ford has been appointed sales engineer for Tod Pazdral Pipeline Specialties. He will assist Tod Pazdral, company president, with TOPAZ consulting engineering, inspecting, testing and internal cleaning services. Ford's experience includes 16 years in various engineering capacities in pipe line construction, gasoline plant and refinery construction. Ford was previously employed by Houston Pipeline Company as assistant chief engineer.

F. A. Ford

•

Stevenson to Head New Office Of Mason-Neilan in California

Mason-Neilan Regulator Company, manufacturers of industrial controls, has announced the appointment of David A. Stevenson as head of the company's new district office in San Francisco.

The office, located at 111 Sutter Street, will be headquarters for sales and service activities in northern California.

Stevenson was previously on the sales engineering staff at Los Angeles.

YOUNGSTOWN LINE PIPE EASY TO BEND

●Discuss this advantage with your men in the field. They will tell you that Youngstown A.P.I. Electric Weld Line Pipe is easy to bend. Youngstown experience permits control of chemical composition to get optimum ductility. This quality makes possible smooth, accurate, unwrinkled bends in the pipe line.

SPECIFY QUALITY V YOUNGSTOWN I SERVICE

ELECTRIC WELD **LINE PIPE**

THE YOUNGSTOWN SHEET AND TUBE COMPANY

Manufacturers of Carbon, Alloy and Yoloy Steel

General Offices: Youngstown 1, Ohio • Export Office: 500 Fifth Avenue, New York 36, N. Y.

For more data on advertised products, use Readers' Service Cards, last page.

MERCOID®

PRESSURE & TEMPERATURE CONTROLS

ENGINEERED FOR SEVERE OPERATING CONDITIONS

Series "D"

Only Mercoid Offers

● ***HERMETICALLY SEALED CONTACT***

Always dependable—whether it operates once per year or several times per minute. It remains operative at all times because dust, dirt, grease or moisture cannot contaminate the contacting elements. There can be no sticking or welding of the contact points.

● ***OUTSIDE ADJUSTMENTS***

Independent outside adjustments are provided for setting both the cut-in and cut-out points. Differential may be widened as desired. No tools are required.

● ***VISIBLE CALIBRATED DIAL***

No guesswork or calculations are required—the pointers indicate on an accurately calibrated dial, the exact operating pressures or temperature.

● ***VISIBLE OPERATION***

You can tell at a glance whether switch circuit is on or off.

● ***BOURDON TUBE OPERATED***

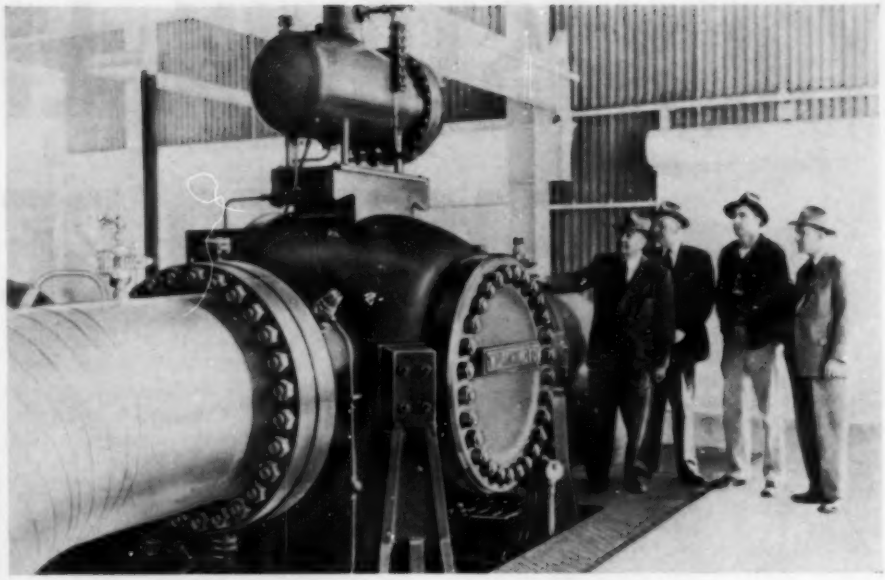
UNDERWRITERS' APPROVED

All operating ranges for Series DA-21, DA-35 and DA-55.

Available for general use, outdoor use or hazardous locations.

WRITE FOR BULLETIN 4B

THE MERCOID CORPORATION
4211 Belmont Ave., Chicago 41, Ill.



Officials Inspect New Unit—

Officials of Northern Natural Gas Company and Worthington Corporation inspecting a new single-stage centrifugal compressor recently installed at Northern's Macksville, Kansas, booster station are, left to right: J. B. Zachry, engine specialist at Worthington's Houston office; H. C. Barten, Worthington Buffalo Works; E. O. Bacon, superintendent at Macksville station, and Earl Harris, Jr., A. M. Lockett & Company. The unit was designed for a rated flow of 748 million cubic feet per day.

Utah Mill Begins Operations For Consolidated Western

Sections of steel pipe began rolling recently from Utah's newest industrial plant, the expanded steel pipe mill of the Consolidated Western Steel division of U. S. Steel Corporation.

The beginning of operations signaled the completion of the overall plant, which was engineered down to the last detail to clear 114 acres of Utah farmland and start operations in approximately six months. Ground was broken at the plant site early in October, 1954.

The new mill, which is located across from the Geneva Works of United States Steel's Columbia-Geneva Steel division, will produce electric weld pipe for transmitting natural gas, petroleum products, and water. More than five acres are under roof, covering two 980-foot long work bays, one of which is fully equipped for the manufacture of the large expanded line pipe in sizes from 20 to 36 inches in diameter. Other principal structures on the property will be an office building, now under construction, and a building to house equipment for coating and wrapping of small diameter pipe. Rest of the site will be reserved for pipe storage.

made for rugged use...
in plant—office or field

Gotkool

water cans and coolers

"GOTKOOL" Water Cans are easily portable for field use . . . and **"GOTKOOL" Water Coolers** are especially designed for use in office, store, or plant. Both have extra large top openings. Snug-fitting, easily removable tops protect water from impurities. Heavy construction with heavy double-locked, sweat-soldered seams. *Buy* **"GOTKOOL"** *at your supply store today.*

GOTKOOL Water Cooler — made in 2, 3, 5, 8, 10, 15, and 20-gallon sizes with extended or recessed flush-mounted faucet optional. *(Note: 15- and 20-gallon sizes available with extended faucet only.)*

GOTKOOL Water Can — made in 1½, 2, 3, 5, 10, and 20-gallon sizes without faucets. Extended or recessed flush-mounted faucets available at slight additional cost. *(Note: 15- and 20-gallon sizes available with extended faucet only.)*

H. P. GOTT MFG. CO.
WINFIELD, KANSAS

KEEP PURE DRINKING WATER ALWAYS HANDY

buried a million years
...now serving the nation

A new titan is at your beck and call!

Natural gas, the giant imprisoned in the earth until the pipeline unleashed its mighty power.

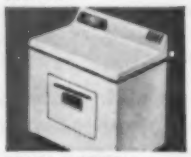
Now a billion and a half cubic feet of the world's finest fuel flow daily through the 2200-mile pipeline of Tennessee Gas. The nation's longest, this great artery brings natural gas from the Southwest where most of it is to the fuel-hungry East where it's needed most.

And does it by the simplest, most direct means of transportation known ... delivers it dependably, economically to homes and industry round the calendar and clock ... by pipeline.

HOME HEATING

COOKING

HEATING WATER


DRYING CLOTHES

TENNESSEE GAS
TRANSMISSION COMPANY
HOUSTON, TEXAS

AMERICA'S LEADING TRANSPORTER OF NATURAL GAS

One of a series of advertisements appearing in full color in national publications.

KEEPING AMERICA INFORMED! Natural gas ... an industry that grows in size, importance and service to the nation every year. The TENNESSEE GAS TRANSMISSION COMPANY is proud to publish these advertisements ... which tell the facts to the American people ... for the benefit of the entire industry.

TENNESSEE GAS TRANSMISSION COMPANY
HOUSTON, TEXAS

Pearce Equipment Company Made Houston Subsidiary of Waukesha

Pearce Equipment Company, Inc. has been organized in Houston as a subsidiary of Waukesha Sales & Service, Inc. The company will be exclusive distributor in the Houston-Gulf Coast area for Clark Equipment Company's Michigan line of construction machinery equipment.

Louis M. Pearce, Jr. is president of the new company. Other officers are D. B. Jeffries, general manager; Earl Gray, service manager; Harry Goss, sales engineer, and Ed Davis, sales engineer.

Pearce Equipment will carry a complete line of parts and offer the same service for Clark equipment that Waukesha Sales and Service, Inc. offers for oil field equipment.

Equipment is available on the Michigan lease plan through Clark Leasing Corporation. Warehouse and service department for Pearce Equipment are located at 1506 Maury, Houston.

Tolliver Heads Tube Turns Sales Development Division

Jack D. Tolliver is manager of the recently established Sales Development division of Tube Turns. The division succeeds the company's Engineering Service division, formed in 1945, and will be staffed with the same personnel.

Tolliver joined Tube Turns as an engineering-sales trainee in 1949. He was assigned to the Engineering Service division in 1950 and became assistant manager in 1954.

Honored on Anniversary

E. E. Smith, left, Southwestern area sales manager for U. S. Steel's National Tube division, Dallas, congratulates James R. Boax, Houston sales manager, on his 25 years of service with U. S. Steel. Boax joined the company in 1930 as a trainee with National Tube.

Sherman Products Appoints Manager for Product Research

John C. Scowcroft has been appointed manager of the Product Research department in the Sales division of Sherman Products, Inc. Scowcroft has been with Sherman since 1946, and has served as manager of the sales office since 1953. He will be succeeded in this capacity by Kenneth Kampman of the Sales division.

The Product Research department is a new branch of the organization made necessary by a current sales and product expansion program which requires extensive research and analysis of new markets and product applications.

Hoenie and Smith Named Lincoln Chief Engineers

Appointment of two chief engineers for The Lincoln Electric Company has been announced. Norman J. Hoenie has been appointed chief engineer, Machine division; Emmett Smith, chief engineer, Electrode division. Both men, prior to their appointment, have been assistant chief engineers of the respective divisions.

Hoenie joined the Lincoln Engineering department in 1931 as a development engineer. Smith joined the company as a development engineer in 1928.

PIPE LINE INDUSTRY

"He wants to know if there's any chance of using this pipe line to move some moonshine to town."

ToPaz
has the answer to
CORROSION

WITH

- ✓ Holcombe Selenium Rectifiers
- ✓ Lion Asphalt Pipe Coatings
- ✓ Fiberglas & Asbestos Wraps
- ✓ Graphite Anodes
- ✓ Coke Breeze

Counteracting corrosion of underground pipes can mean tremendous savings for your company. As part of it's famous "one for all" service ToPaz distributes the complete Holcombe Company line of pipeline protection equipment and supplies.

You can trust ToPaz for high quality, dependable corrosion prevention equipment at all times. You can depend on ToPaz fast delivery and prompt, personal attention to your order. Contact ToPaz for all pipeline equipment and supplies. You'll get the job done faster with ToPaz helping you.

Topaz Offers Complete Engineering, Consulting, Testing, Inspecting and Internal Cleaning Services

AGENTS FOR:
T. D. WILLIAMSON, INC.
THE HOLCOMBE CO., INC.

Tod Pazdral
PIPELINE SPECIALTIES

ToPaz

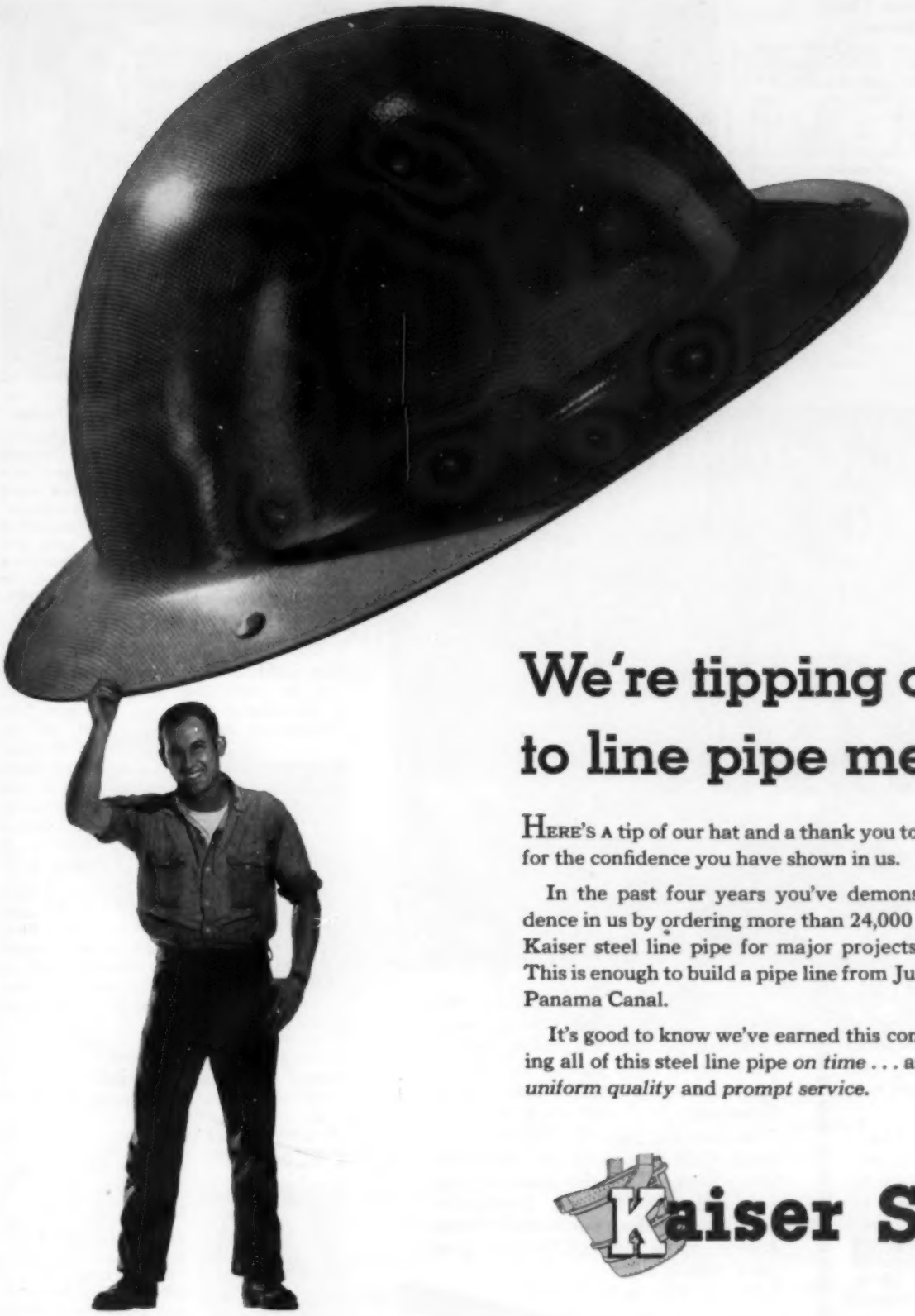
2525 South Blvd. • Houston, Texas • Office Phone JA-2-1403

Tod Pazdral
F. A. (Jim) Ford
Consulting & Supervision
Home Phone MA 3-5680

Jack Pelkey
Sales & Service
Atlanta

Richard Lee McHenry
Sales & Service
Dallas

GROVE SEAL "O" RING VALVES • TIPTON WELDING CLAMPS, HOOKS & DOLLIES • ALSTON PIPE CUTTING MACHINES • FLEETLINE PIPE SADDLES & REDUCERS • H & M CUTTING & BEVELING MACHINES • ANDERSON EQUIPMENT CO. HEAVY MACHINES • ORDER FROM TOD PAZDRAL



We're tipping our hat to line pipe men!

HERE'S A tip of our hat and a thank you to you line pipe men for the confidence you have shown in us.

In the past four years you've demonstrated your confidence in us by ordering more than 24,000 carloads of Basalt-Kaiser steel line pipe for major projects the country over. This is enough to build a pipe line from Juneau, Alaska to the Panama Canal.

It's good to know we've earned this confidence by delivering all of this steel line pipe *on time* . . . and by assuring you *uniform quality* and *prompt service.*

Kaiser Steel

KAISER STEEL PIPE SPECIFICATIONS • All pipe manufactured to latest A.S.T.M. and A.P.I. specifications

Type	Diameter	Length	Wall Thickness	Shipping Point
Continuous Weld—Threaded and Coupled	½" to 4" nominal I.D.	Uniform 21'	Standard	Fontana, Calif.
Continuous Weld—Plain End	2⅜" to 4½" O.D.	Up to 40'	Standard	Fontana, Calif.
Electric Resistance Weld—Plain End	14" to 18" O.D.	Up to 40'	.250" to .500"	Napa, Calif.—Basalt-Kaiser
Electric Resistance Weld—Plain End	5⅝" to 12¾" O.D.	Up to 55'	.188" to .375"	Fontana, Calif.
Electric Fusion Weld—Expanded—Plain End	20" to 30" O.D.	Up to 40'	.250" to .500"	Napa, Calif.—Basalt-Kaiser

Prompt, dependable delivery at competitive prices • KAISER STEEL CORPORATION Los Angeles, Oakland, Seattle, Portland, Phoenix, Denver, Tulsa, New York

General Electric Names Three New Welding Distributors

Three new distributors have been designated to handle products of General Electric Company's Welding department.

The distributors, all of which will handle sales and service of G-E's line of arc welders, electrodes, and accessories, include: Weld-Arc Sales and Supplies, Inc., New York City; Interstate Welding Supply Corporation, Elizabeth, N. J.; and T. H. Green Company, Rochester, N. Y.

J&L Supply Division Promotes Wolfe to Sales Vice President

William L. Wolfe has been appointed vice president—sales of Jones & Laughlin Steel Corporation's Supply division, with headquarters in Tulsa. He was formerly assistant to the vice president—sales of J&L at the company's general office in Pittsburgh.

BRADEN WINCHES ARE:

★ **SAFE:** Up to 50% more reserve pulling and holding power than ratings indicate.

★ **STRONG:** Engineered for ruggedness. All moving parts, such as worm gears, made of steel and bronze alloy.

★ **GUARANTEED:** All BRADEN "M" Series Winches are guaranteed against defective workmanship & material for 1 year from date purchased.

BRADEN Truck Winches are engineered with as much care as many more complicated machines. Special alloys make them lighter but special engineering combines minimum dimensions with maximum strength.

Sure-action controls and the patented Oil-Cooled, Fully Automatic Safety Brake make the operator's job easy and safe. Longer, dependable service under the most strenuous conditions make BRADEN your best truck winch buy.

See Your BRADEN Dealer or Write for Complete Catalog

BRADEN WINCH COMPANY

P. O. Box 547, Broken Arrow, Oklahoma

BRADEN Winches

Motorizes Field Training Units

Four field training units have been placed in service by the Tractor division, Allis-Chalmers Manufacturing Company to bring at-the-dooor service training on the company's new diesel engines to industrial dealer service organizations. A unit with two-man crew is assigned to each of the company's industrial sales and service territories. Each unit carries a tear-down engine, an operating diesel engine, cutaway assemblies, sub-assemblies and visual aid facilities for a comprehensive training program.

T. D. Williamson, Inc. Appoints New California Representative

T. D. Williamson, Inc., manufacturers of specialized equipment for pipe line maintenance and construction, has announced the appointment of Alfred Kent of Alfred Kent & Son as its new California representative. Kent has been associated for many years with the refinery, natural gas and pipe line industries in the distribution of mechanical equipment throughout the Mid-Continent and Gulf Coast areas.

Alfred Kent

De Laval President Stewart Named NICB Board Member

J. P. Stewart, president of the De Laval Steam Turbine Company, was elected a board member of the National Industrial Conference Board at the board's 156th meeting held at the Waldorf - Astoria Hotel, New York.

J. P. Stewart

The Conference Board, founded in 1916, is an independent and nonprofit institution for business and industrial fact finding through scientific research. The board is a source of facts and figures bearing on all aspects of economic life and business operation. Work of the board is made possible through the support of more than 3300 subscribing associates including business organizations, trade associations, government bureaus, labor unions, libraries, individuals and educational institutions.

20,772 hours...2½ years of trouble-free service at Plantation Pipe Line's Akron, Alabama, Station*

...typical of

JOHN CRANE 8-B

SEAL PERFORMANCE

***Case History**

"John Crane" Type 8-B Seals were installed in two high pressure 3-stage centrifugal pumps at the Akron, Alabama, Station, operated by Plantation Pipe Line Co. Pumps operated for 2½ years without shutdown. At the end of that time they were opened for inspection and parts repair. The seals, including rubber parts, were in perfect working condition. New 8-B Seals were ordered to insure repetition of this remarkable performance record. Old ones were rebuilt to serve as spares.

Here is further proof that wherever service is tough "John Crane" 8-B Seals are successfully doing the job. This is the reason why 75% of the seals installed in crude and product pipe lines within the last several years have been "John Crane" Seals.

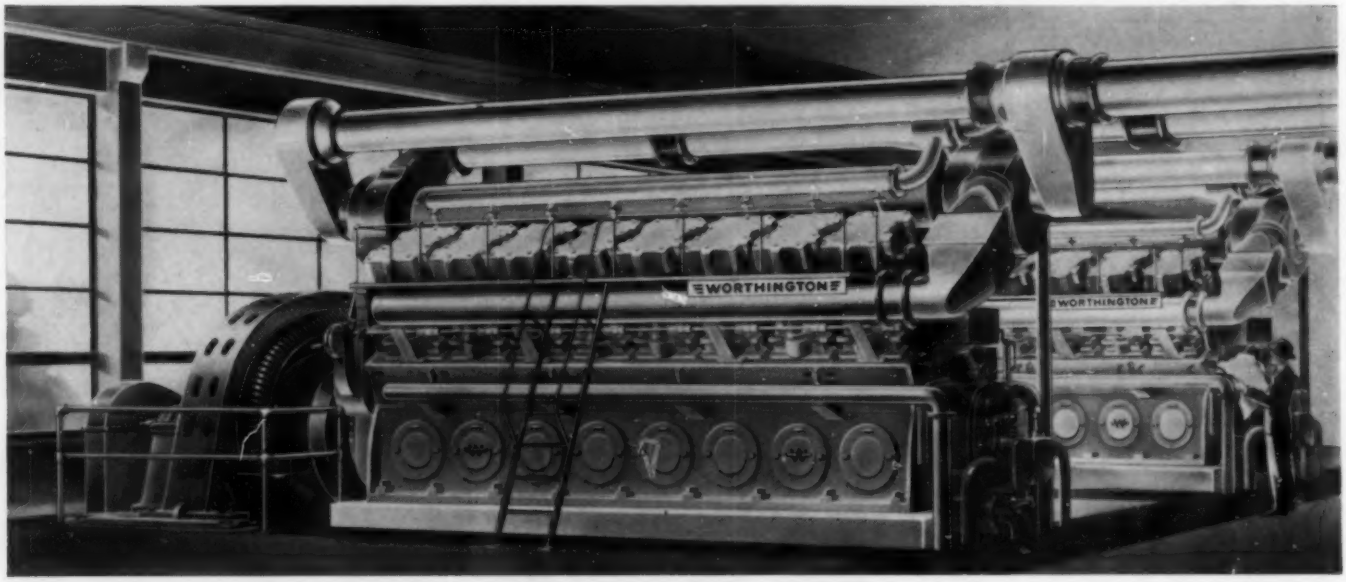
You can get this same performance. Contact Crane Packing Co., 1834 Cuyler Ave., Chicago 13, Ill. *In Canada: Crane Packing Co., Ltd., 617 Parkdale Ave., N., Hamilton, Ont.*

JOHN CRANE **CRANE PACKING COMPANY** 38 YEARS INDUSTRIAL PROGRESS

OFFICES IN PRINCIPAL CITIES

What's New in Equipment

for the Pipe Line Industry



Reciprocating Engine

Newest thing in the pipe line industry is Worthington's SW14 engine in production at the company's Buffalo Works. Generally recognized to be the first heavy duty relatively low speed engine in the U. S. designed for continuous operation at brake mean effective pressures beyond 200 pounds per square inch, its top rating is 5000 horsepower at 200 psi.

Cylinder combinations are 6, 8, 12 and 16. Six and eight-cylinder engines are built in line; the 12 and 16 cylinder units are Vee type. They are 14-inch bore by 18-inch stroke.

Highly adaptable, the engine can be converted to oil diesel, dual fuel diesel, spark ignition gas engine or tri-power engine.

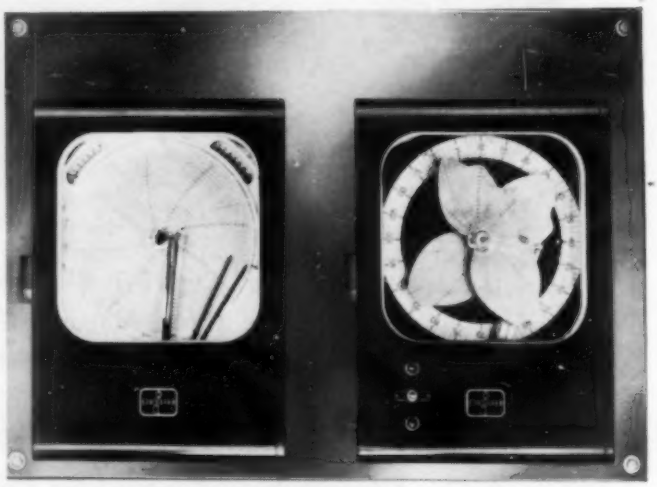
Interchangeability of major parts, governor, cylinder heads, cylinders, pistons, connecting rods, precision bearings, bearing caps, fuel pumps, fuel nozzles and small parts used in building 6, 8, 12 and 16 cylinder engines, proves of extra value to the user with power requirements calling for both the in line and the Vee engines in the same plant. Both engines have 14-inch crankshaft and 5½-inch diameter camshaft.

Featured in the design of the engine are cylinder heads with high volumetric efficiency, through flow scavenging, self-aligning exhaust valve seat inserts, hydraulic valve lifters, and upper valve stem guides; pistons with controlled flood cooling and dished crown design; cylinders with cast-in water jackets suitable for high temperature cooling and arranged so that all water connections are outside of the frame; dry type exhaust manifold for highest turbocharger efficiency and reduced cooling water requirements; and Worthington cast-in lubricating oil header and positive pressure lubricating oil system. The lubricating oil pump is directly driven from the engine crankshaft. Arrangements for gear driven attached soft and raw water pumps from the engine crankshaft, and conventional closed-end, die forged connecting rods in both the in line and the Vee engines are other features.

(This item supplements Worthington Corporation data on Pages 5221-5240 of the Composite Catalog, 20th Edition.)

For more data circle **No. E1** on Readers' Service Card, last page this issue.

Controller Instrument



An instrument which combines in a compact two-case unit a two-pen, two-cam time-program controller with a cycle controller which times up to eight operations has been announced by The Bristol Company. The cases can be mounted side by side or one above the other to suit particular space requirements.

The time-program controller can be used to control two variables such as temperature, humidity, pressure or vacuum through any predetermined program of values by means of an aluminum cam cut to proper shape. Each of the two cams is individually cut, and locked together in any desired time relationship on a single hub. In this way, temperature can be controlled through one cycle of changing values while pressure is going through another cycle independently, but synchronized with temperature.

The two cams can be changed as a unit, altering the program performed to meet varying requirements. The program controllers are available in on-off or proportional electric control, or pneumatic control in proportional, reset, or derivative modes.

At the same time, such operations as the opening and closing of valves, switches, and dampers, and the starting and stopping of motors, pumps, and blowers can be timed automatically by the cycle controller. This controller operates up to eight high capacity air valves or electric switches, in any combination desired.

For more data circle **No. E2** on Readers' Service Card, last page this issue.

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to protect

QUALITY

ENGINE LIFE

The Symbol of

QUALITY FILTRATION

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use **ENGINE LIFE**

Engine Life's outstanding performance in the field of filtration is the result of constant proving and improving of the various elements, filtering media and designs in the never-ending quest for perfection. Engine Life's comprehensive coverage of replacement elements and filtering equipment, combined with specialized filter research laboratory and engineering staff, is available to competently determine the best answer to your filtering requirements. Where absolute dependability, quality and performance are essential, Engine Life's modern design filtering equipment and engineered replacement elements are your assurance of the ultimate in oil conditioning.

A COMPLETE LINE OF ENGINEERED REPLACEMENT ELEMENTS

ENGINE LIFE *Products Corporation*

EL MONTE, CALIFORNIA

ENGINEERED FILTRATION SERVICE

INDUSTRIAL AGRICULTURAL AUTOMOTIVE & MARINE

As SIMPLE and Dependable as the Pull of a MAGNET!

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is

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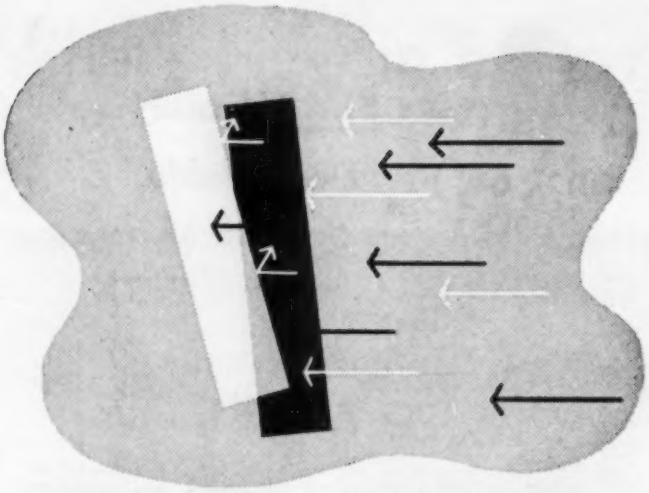
Linked to liquid level by infallible magnetic force, Magnetrol is free from the limitations inherent in mechanical or electrical controls. With the actuating magnet rated at 98% of initial strength after 30 years, Magnetrol has *infinite operating life*, with practically no maintenance at all. There are no wearing parts to get out of order.

What's more, Magnetrol's simple operating principle permits easy, economical modification of standard units to meet *any* pressure, temperature or corrosion requirements. That's why there's practically no limit to Magnetrol's use. It's also why "specials" are likely to be standard with us. Magnetrol units control level changes from .0025-in. to 150-ft. —with single or multi-stage switching.

MAGNETROL, Inc.

● *SEND COUPON FOR DETAILS*

MAGNETROL, Inc. 2128 S. Marshall Blvd., Chicago 23, Illinois
Please send me catalog data and full information on Magnetrol Liquid Level Controls.
Name_____
Company_____
Address_____
City_____ Zone_____ State_____



Radioisotope Laboratory For Oil Industry Opened in Houston!

A radioisotope laboratory solely for supplying the petroleum industry with special tagged compounds has been opened in Houston at 2419 South Boulevard by Tracerlab, Inc. The laboratory will stock and ship on 24-hour notice all the short lived isotopes and standard tagged chemicals now being extensively used, and will thus overcome present serious delivery problems.

Tracerlab has been supplying compounds to oil companies for several years from its Boston, Massachusetts and Richmond, California laboratories. The growing volume of orders has made it practical to establish a special laboratory in a location more convenient for the majority of users.

Many standard compounds utilized by the oil industry are to be packaged and sold under the firm's trade names: TraceSols, which are radioisotope solutions or volatile or gaseous compounds; and TraceOids, which are radioactive isotopes in the form of particulates. These compounds can be shipped on 24-hour notice or less, if the ordering firm's general authorization from the Atomic Energy Commission is on file.

Descriptive sheets on TraceSols and TraceOids, complete with specifications, prices and illustrations of some of the applications, are available on request.

HOUSTON LABORATORY

2419 South Boulevard, Houston, Texas, Tel.: JAckson 2-9401

130 HIGH STREET, BOSTON 10, MASS. — Tracerlab® INC — 2030 WRIGHT AVENUE, RICHMOND 3, CALIF.

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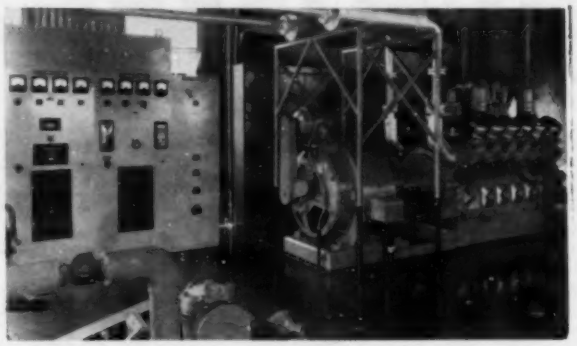
READY WHEN NEEDED

DEPENDABLE—EFFICIENT



These important units at a major company's gas compressor station were furnished through us. Where dependability, long life and efficient service are requirements, LeRoi Engines continue to make Oil Country history.

For 46 years Southern Engine & Pump Company has been serving industry with power units for every requirement. Skilled mechanics and competent engineers are available to serve you. We invite your inquiries.

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Oil Field Stations **Electrical Installations**

NEW EQUIPMENT . . .

Surface Alloy Process

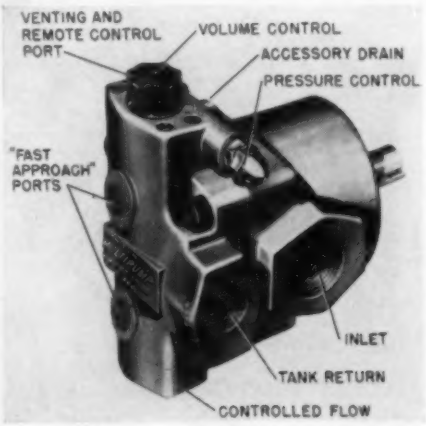
A new, modern process that diffuses chromium into ferrous metals and forms a stainless surface alloy to depths from 0.001-inch to 0.008-inch and more without causing dimensional changes has been developed by Alloy Surfaces Company.

The process will permit ferrous metals to resist corrosion even under the most severe atmospheric, water and chemical corrosion conditions; resist thermal oxidation even at temperatures to 1700° F and resist wear and abrasion under a wide variety of difficult applications. The surface will not chip, crack, peel or gall even when the processed product is bent 180 degrees, stretched or twisted.

Products can be welded before or after processing, the mild steel procedures being used before processing, the stainless steel welding procedures, after processing. In addition, they can be brazed, arc welded and spot welded. In spot welding after treatment, the mild steel procedures are still used.

The process makes available parts and assemblies with resistance characteristics at costs less than stainless steel fabrication and it has unlimited applications wherever the advantages of stainless steel are required on large and small metal products.

For more data circle **No. E3** on Readers' Service Card, last page this issue.



Hydraulic Pump

A new variable volume vane pump, the Multipump, has been introduced by The Denison Engineering Company. It will deliver variable volume at constant speed or constant volume at variable speed, and is available in three basic sizes with capacities of 5, 15 and 25 gpm at 1200 rpm, all designed for 1000 psi continuous duty.

Features of the new pump include finger tip volume control which works independently of compensator; and a compensator control that works at all volumes, with a stop for minimum volume available. The pump holds volume within 5 percent over desired pressure and designed speed ranges and delivers preset volume and preset pressure to system. By adding an on-off valve, it gives results of cylinder control, and it eliminates need for servo-control as it can be operated by simple push-pull cable.

(This item supplements The Denison Engineering Company data on Pages 1345-1348 of the Composite Catalog, 20th Edition.)

For more data circle **No. E4** on Readers' Service Card, last page this issue.

Why
this Jam-Proof 65R
RIDGID
is most pipe threader for your money

Easiest to Use... Threads 1", 1¼", 1½" and 2" pipe and conduit with 1 set of chasers that adjust to size in 10 seconds. Mistake-proof self-centering workholder sets instantly to size. Threader can't jam—it kicks out automatically when standard length thread is cut. Unbeatable speed, least work.

Perfect Threads... 65R cuts beautiful threads—and you find the factory test sample in your new die stock to prove it. No other threader gives you as much for your money.

Ask to see the 65R at your Supply House. Try it, buy it—it's a bargain in satisfaction.

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RIDGID
Work-Saver Pipe Tools

For more data on advertised products, use Readers' Service Cards, last page.

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GULF COAST'S
Foremost Metallizers

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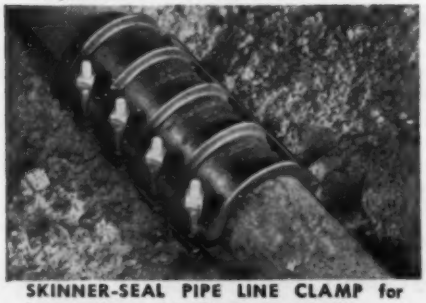
TO REPAIR PIPE LEAKS—
QUICKLY, PERMANENTLY
ANY PRESSURE — ANY TEMPERATURE

SKINNER-SEAL EMERGENCY PIPE CLAMP for pinhole or corrosion leaks.



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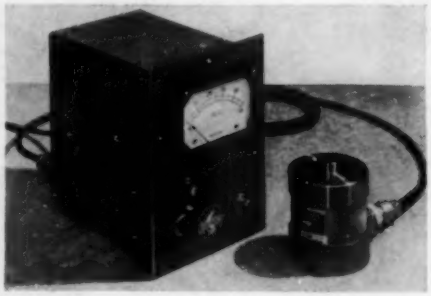
SOUTH BEND 21, INDIANA, U. S. A.

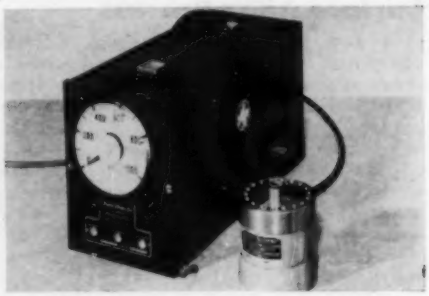
NEW EQUIPMENT . . .



Pressure Indicators

Two new electric indicators have been announced by the Taber Instrument Corporation. These are companion instruments to the company's Teledyne pressure transmitters used for telemetering pressure information from remote or hazardous locations to a central control room up to 500 feet distant.

These indicators are made in two models. The Model 168, left, makes use of a precision meter with a three-inch length of scale. The Model 170, right, is equipped with a circular scale meter having a scale length of seven inches which greatly increases reading accuracy.



This new line of instruments employs an advanced electrical circuit which eliminates components such as 400-cycle choppers and vacuum tubes. There are no moving parts other than those of the meter. Both models operate from 105 to 130 volt, 60 cycle, one phase AC line and include a built-in regulated power supply for operation of the complete transmitter-indicator system, including the strain gage bridge circuit. The connecting leads can be any reasonable length.

For more data circle **No. E5** on Readers' Service Card, last page this issue.

Grader Wheel Design

Allis-Chalmers Manufacturing Company, Tractor division, has announced design changes in its front wheel assembly for the Model D motor grader, to provide greater service and performance from the grader and to add further strength to this accessory.

Design revisions have reduced the number of wear points on the leaning front wheel assembly and on the grader's steering mechanism. Shim adjustments are used to take up knuckle wear, and bushings have been replaced by tapered and roller bearings. Improved control over the leaning operations has resulted from reducing travel speed of the leaning front wheels and adding further strength to the tie rods. The front wheel lean assembly is optional equipment for the standard Model D motor grader.

(This item supplements Allis-Chalmers Manufacturing Company data on Pages 168-169 of the Composite Catalog, 20th Edition.)

For more data circle **No. E6** on Readers' Service Card, last page this issue.

Aluminum Gas Meter

A new aluminum die-cast gas meter for commercial and industrial services has been introduced by Rockwell Manufacturing Company. The large capacity Rockwell "No. 4" weighs only 176 pounds as compared with 600 pounds for Rockwell's cast iron meter of the same capacity and working pressure. Designed for working pressures up to 100 pounds per square inch, its over-all dimensions are 33 by 27 by 19 inches.

Stainless steel inserts provide corrosion-resistant wearable threads in the index plate holes on the cover, the four cap-screw holes at the ends of the body and in both the inlet and outlet. The meter is also equipped with steel feet, ½-inch high, for insulation. All internal parts of the new aluminum meter are interchangeable with those of the cast iron counterpart.

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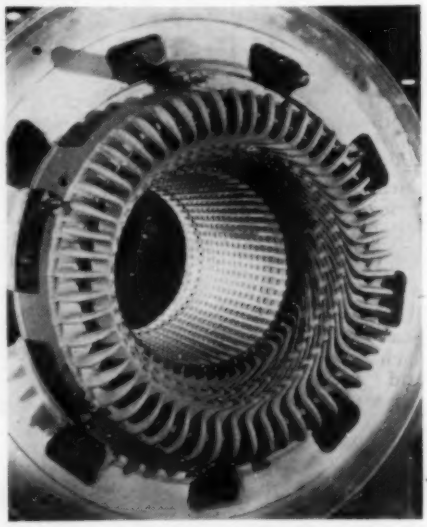

Silicone-Rubber Insulation

Allis-Chalmers Manufacturing Company has announced an all-silicone-rubber insulating system for large motors and generators. Known as the Silco-Flex system, it is available for all Class H insulated form wound coils and for Class A and B windings operating under certain service conditions. Using as its basic material Dow-Corning's Silastic silicone rubber, Silco-Flex insulation makes available the advantages inherent in silicone base insulations, while overcoming previous application problems.

In performance, the new insulating system offers these advantages: heat resistance, moisture resistance, abrasion resistance, flexibility and resilience, chemical inertness, and improved heat dissipation.

Shown is a stator for 2500 horsepower, 2300 volt, 3580 rpm squirrel-cage induction motor wound with Silco-Flex insulation. This motor will operate under extreme moisture conditions.

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New Equipment Literature

For more data on New Equipment or copies of Catalogs and Literature reviewed in this issue, use the Reader Service postcards just inside the back cover and facing the Advertisers Index. Simply circle code numbers of items desired—sign and mail card.

Tractor Booklet

A booklet on the Caterpillar D8 tractor, showing the new unit in both torque converter and direct drive models, has been released.

Some of the advance designs mentioned in the booklet are engine, controls, live shaft drive, welded one-piece steering clutch case, 7-roller track frame, water-quenched track shoes, hydraulic booster steering, starting engine, in-seat starting, larger fuel tank and new attachments. Specifications on both torque converter model and direct drive model are included.

To get a copy circle **No. E9** on Readers' Service Card, last page this issue.

Air Impactool Catalog

A new Ingersoll-Rand catalog devoted to the problem of running nuts, bolts, cap screws and other type fasteners has been released by the company. Actual case histories substantiate the claims that lightweight Air Impactools help reduce fastening costs.

The catalog contains the complete line of Air Impactools manufactured by Ingersoll-Rand, showing illustrations, specifications and equipment furnished with each tool. On-the-job application pictures and case history studies are also included. Accessories and sockets used with the tools are shown, and the complete line of Ingersoll-Rand air tools, universal electric impactools, multi-cycle electric tools and other I-R products are illustrated and described.

To get a copy circle **No. E10** on Readers' Service Card, last page this issue.

Liquid Level Bulletin

A new bulletin describing the complete line of liquid level gages for indicating, recording, controlling and telemetering has been released by The Bristol Company. The booklet shows float-type, pressure-type, differential pressure-type and bubble-type liquid and water level gages, in strip and round-chart models. Air or electric controllers are available in several models.

A new weatherproof case designed for surface or pole mounting outdoors is shown for the 8 and 12-inch round chart recorders and controllers.

Other new instruments featured include Bristol's time-liquid level program controllers, for raising and lowering the level of a given vessel according to a predetermined schedule and rate, and the new miniature graphic-panel metagraphic pneumatic transmission instruments for liquid and water level measurements.

Engineering data on the choice of the proper bulb, and instrument for a given installation are presented, as well as installation information on liquid level telemetering and remote control.

To get a copy circle **No. E11** on Readers' Service Card, last page this issue.

Pipe Shield Brochure

W. R. Meadows, Inc. has announced publication of a brochure covering their sealtight pipe shield, a sturdy, flexible, asphalt mastic board manufactured in job-specified sizes. Scored every inch and easily formed and stripped to pipe, the shield provides a positive protection against all rock damage and eliminates the expense of dirt padding.

To get a copy circle **No. E12** on Readers' Service Card, last page this issue.

Cooler-Separator Manual

The R. P. Adams Company has published a new bulletin on aftercoolers and separators, designed to help management minimize the hidden costs of compressed air systems.

It offers suggestions as to the scope of a realistic cost accounting of compressed air systems, with a fill-in type check list to help analyze how effective a job is being done by the aftercooler in use. A chart covering moisture content of air under pressure at various system temperatures, cut-away illustrations in color of Adams aftercoolers, cyclone separators and Poro-Stone air filters, and size and capacity charts of these units are also included.

To get a copy circle **No. E13** on Readers' Service Card, last page this issue.

See Composite and Refinery Catalogs, or Write for Specifications Folder

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PIPE SADDLES AND REDUCERS

Nozzle sizes from ¼" to 24"

ASTM A234

Also for pressure vessel heads

Nominal pipe sizes 1" to 30"

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Special sizes and lengths. Schedules 10 to 160 Stainless Steel, and other Alloys.

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PELICAN SUPPLY CO. INC.

P. O. Drawer 1108 Shreveport (84), La.

SEE YOUR NEAREST SUPPLY HOUSE

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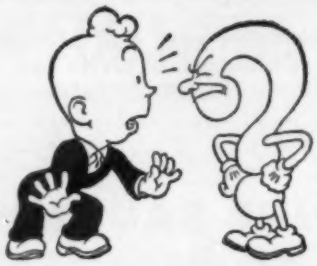

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Scale and Corrosion in Diesel Rigs and Radiator Cooling Systems? USE

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Established 1926
FREEPORT, NEW YORK

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BRAKESOL is ECONOMICAL, prevents or removes Paraffin from the tubing, flow lines, tank bottoms and pipe lines. Effective on both asphalt and mixed base paraffin.

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BRAKESOL, Inc.

P. O. Box 9506 **Oklahoma City, Okla.**

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Reinforced GUNITE COATING being applied to pipe.

Your inquiry solicited.

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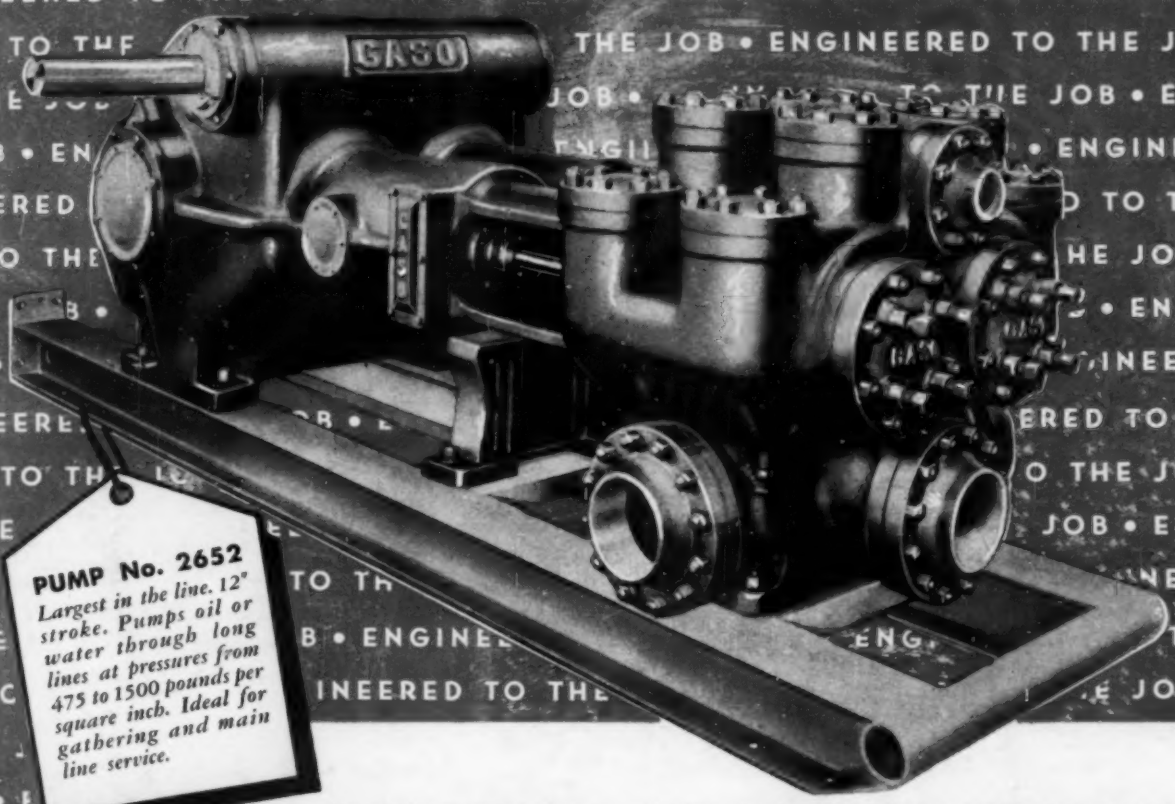
PIPE LINE INDUSTRY

CONSTRUCTION

OPERATIONS

MAINTENANCE



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Largest in the line. 12" stroke. Pumps oil or water through long lines at pressures from 475 to 1500 pounds per square inch. Ideal for gathering and main line service.

MANY MODELS AND SIZES TO ASSURE PUMPS

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